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S-IVB-206 STAGE FLIGHT TEST PLAN

DOUGLAS REPORT SM-46979
20 DECEMBER 1966

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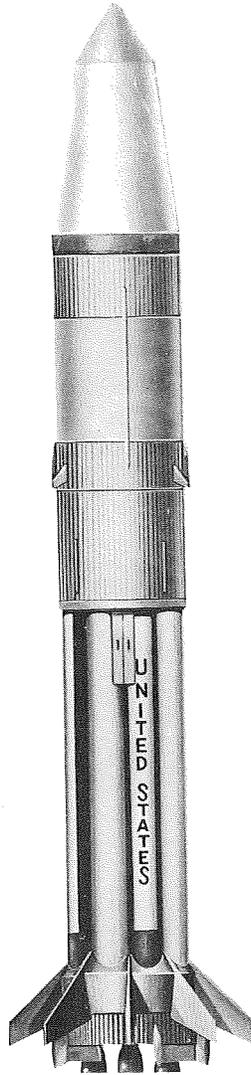
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PREPARED FOR:
NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION
UNDER NASA CONTRACT NAS7-101



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AS-206 LAUNCH VEHICLE



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ABSTRACT

DAC Report No. SM-46979, S-IVB-206 Stage Flight Test Plan documents the Douglas requirements and responsibilities relative to the S-IVB-206 stage of the AS-206 vehicle flight test that will be conducted by NASA at the Kennedy Space Center. The test plan defines DAC support activities and reports required under NASA Contract NAS7-101. Stage performance and mission objectives are defined; each includes criteria for its evaluation.

DESCRIPTORS

AS-206 mission	sequence of events
S-IVB-206 stage mission	mass characteristics
configuration	predicted flight performance
CPIF (cost plus incentive fee)	J-2 engine

PREFACE

This document presents the DAC flight test plan for the S-IVB-206 stage. In general, it provides information and direction to DAC personnel at Huntington Beach, Florida Test Center, and Marshall Space Flight Center.

Detailed descriptions of the following are included in this document: vehicle mission, stage objectives, CPIF technical performance criteria, stage configuration, basic differences from the S-IVB-205 stage, instrumentation and measurement requirements, propellant loading requirements, sequence of events, and mass characteristics. Propulsion system performance predictions are also included in accordance with the requirements of NASA/MSFC contract letter I-V-S-IVB-TD-66-45, dated 7 July 1966.

Documentation used in support of data contained in this test plan are listed in appendix 11.

This report was prepared by the Saturn S-IVB Test Planning and Evaluation Committee at the Huntington Beach Space Systems Center for the National Aeronautics and Space Administration. It was authorized by NASA Contract NAS7-101 and issued in accordance with the contractual requirements of DAC Report No. SM-41410, Data Submittal Document Saturn S-IVB System, revised 1 December 1965.

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1. INTRODUCTION

This document delineates the requirements and responsibilities of the Douglas Aircraft Company, Inc. (DAC) in support of the flight test program of the S-IVB stage of the Saturn IB vehicle AS-206. The overall flight test program (with contractor participation) will be conducted by National Aeronautics and Space Administration (NASA) at the Kennedy Space Center (KSC), Florida.

1.1 Background

The S-IVB-206 stage was assembled at DAC/Huntington Beach (HB), California, where production tests of components and systems were accomplished. The stage was then transported to DAC/Sacramento Test Center (STC), where the acceptance firing test program was conducted. This program consisted of manual and automatic subsystem checkouts, integrated systems tests, a simulated acceptance firing countdown, and an automatic propellant loading test. A full duration acceptance firing test followed these preliminary tests. The firing demonstrated the adequacy of the S-IVB-206 stage systems to perform at sea level conditions. Postfire checkout included manual leak checks, functional tests, and an all systems test (AST) using stage internal power (battery simulator) and a simulated instrument unit. The stage was then shipped to DAC/Florida Test Center (FTC) and upon arrival subjected to post transportation receiving inspections and then mated to the assigned after inter-stage. At the time of launch, the S-IVB-206 stage will also have undergone prelaunch stage systems checkouts and integrated launch and space vehicle systems tests. (See figure 1-1 for test history of S-IVB-206.)

1.2 Flight Test Plan Definition

Saturn vehicle AS-206 will be the fifth Saturn IB flight vehicle. It will be launched from KSC Launch Complex 37B on a multiple orbit mission, the basic purpose of which is to verify lunar module (LM) subsystems operation, fire-in-the-hole abort, and LM staging characteristics.

The S-IVB-206 stage flight test, as defined in this test plan, will be limited to the S-IVB contribution, as the second stage of the space vehicle, toward the accomplishment of the AS-206 flight mission.

DAC participation and activities delineated by this document encompasses the following areas: (1) launch operations, (2) inflight monitoring of the S-IVB-206 stage, (3) postflight evaluation of mission objectives, (4) submittal of informal evaluation inputs to MSFC flight evaluation working group, and (5) writing and publishing DAC Report No. SM-46991, S-IVB-206 Stage Flight Evaluation Report.

In general, this document provides information and direction to the DAC Saturn S-IVB Test Planning and Evaluation (TP&E) Committees at DAC/HB and FTC, and to the flight evaluation liaison team at Marshall Space Flight Center (MSFC), Huntsville, Alabama. This information includes vehicle mission (section 2), stage objectives (section 3), stage configuration (section 4), instrumentation (section 5), test management (section 6), and CPIF contract technical performance criteria (section 7). Detailed predicted data regarding the AS-206 flight and additional pertinent information are presented in the appendices.

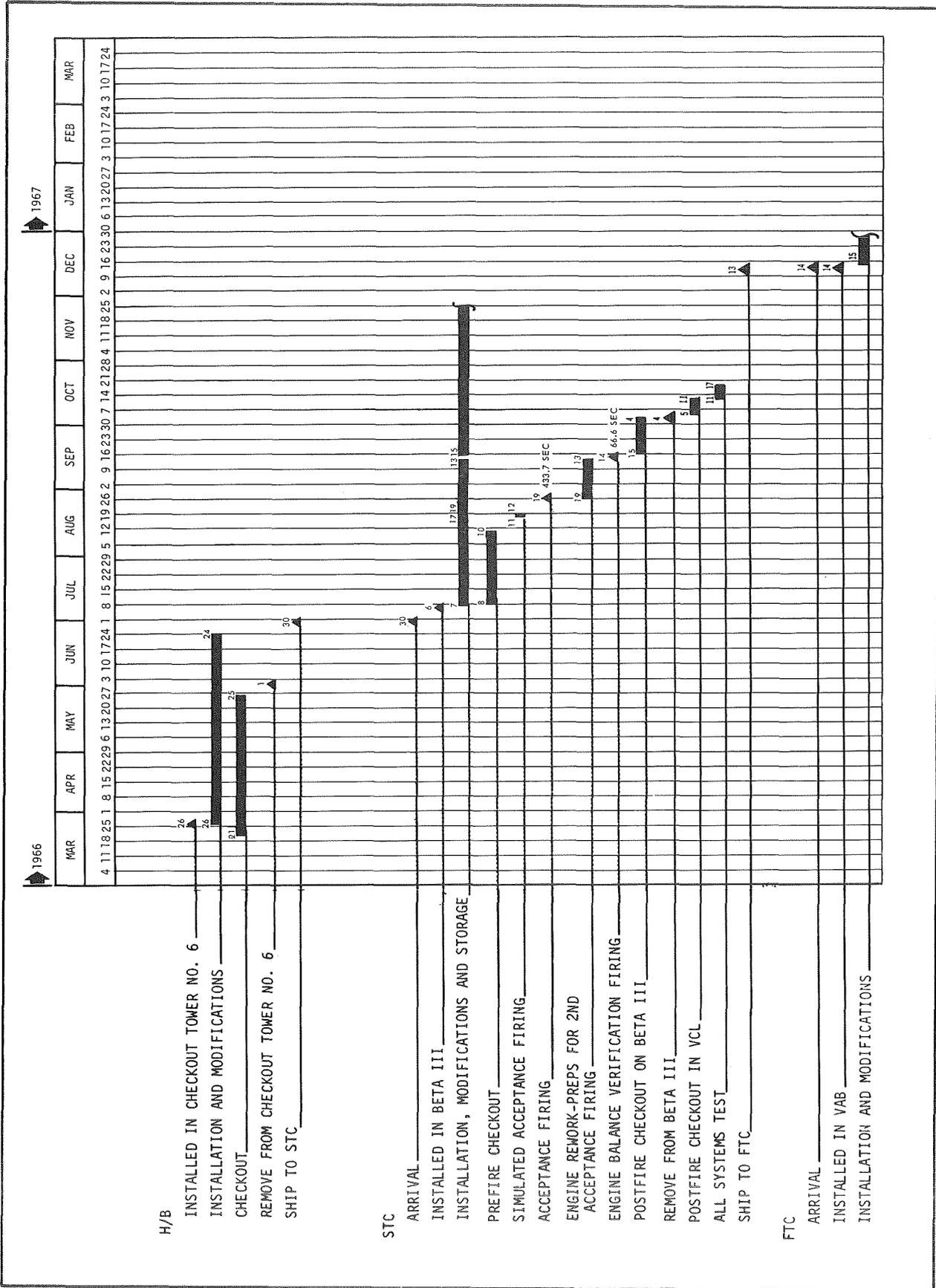


Figure 1-1. S-IVB-206 Stage Checkout and Test History

2. MISSION

The Saturn AS-206 is the fifth Saturn IB flight vehicle and will be the first operational vehicle in the Apollo flight program. It will be the first flight of the lunar module (LM), the basic purpose of which will be to insert the payload into orbit to evaluate LM subsystems operation, fire-in-the-hole abort, and LM staging characteristics.

This section presents the vehicle mission objectives and mission description, and section 3 of this document presents the associated S-IVB stage objectives.

2.1 Mission Objectives

Primary objectives are those which are mandatory. Malfunctions of spacecraft, launch vehicle systems, ground equipment, or instrumentation which would result in failure to achieve these objectives will be cause to hold or cancel the mission until the malfunction has been eliminated.

Secondary objectives are those which are desirable but not mandatory. Malfunctions which may result in failure to attain these objectives may be cause to hold or cancel the mission as indicated in the mission rules.

The primary mission objectives as listed in the Apollo Flight Mission Assignments (reference 1)* are to:

- a. Verify operation of the following LM subsystems: guidance and navigation (G&N); stabilization and control system (SCS); reaction control system (RCS); ascent propulsion stage and descent propulsion stage (DPS), including restart; electrical power system (EPS); structure; environmental control system (ECS); and communications (LM/manned space flight network)
- b. Evaluate LM fire-in-hole abort
- c. Verify uprated H-1 engine performance

The primary and secondary test objectives as presented in the Apollo-Saturn IB Program Support Requirements document (reference 2) are to:

* Detailed information regarding the document can be obtained in appendix 11 (References).

Primary objectives

- a. Verify LM subsystems operation after launch vehicle boost and during and after LM propulsion system operation
- b. Evaluate flight control systems (G&N, SCS, RCS) performance and operation at design inertias
- c. Determine performance and operational characteristics of the EPS, ECS, and operational instrumentation subsystems in earth orbit
- d. Determine LM communications subsystem performance operation, and manned space flight network compatibility
- e. Evaluate DPS and ascent propulsion stage subsystems operation following orbital soaks, including throttle and gimbal control, and demonstrate DPS and ascent propulsion stage restart
- f. Demonstrate fire-in-the-hole abort and evaluate the in-flight dynamics (staging characteristics), pressure distribution, and thermal distribution of the ascent/descent stages during staging.

Secondary objectives

- a. Demonstrate DPS and ascent propulsion stage operation at low propellant quantities
- b. Demonstrate operation of the LM mission programmer.

The AS-206 Flight Mission Directive (reference 3) was not available at the time of this publication but will be included in a subsequent revision.

2.2 Mission Description

The primary mission of the AS-206 launch vehicle is to inject the LM into an 85 to 120 nmi elliptical orbit (figure 2-1).

The vehicle will be launched from Kennedy Space Center, launch complex 37B, on a 100 deg launch azimuth and will rise vertically for 10 sec after which a roll maneuver will be initiated to align the vehicle in a 72 deg flight azimuth plane and pitch to obtain zero angle of attack during the region of maximum dynamic pressure. The maximum dynamic pressure of 740 lbf/ft² will occur at approximately 75 sec. At 142 sec

after liftoff the S-IB/S-IVB stages will separate, utilizing ullage rockets to settle the S-IVB stage propellants and retrorockets to back the S-IB stage and interstage away from the S-IVB/instrument unit/spacecraft (S-IVB/IU/SC). The inertial attitude of the vehicle will be held constant from 10 sec prior to S-IB outboard engine cutoff to the time of ullage rocket jettison (approximately 154 sec), when the iterative guidance mode will be initiated. The S-IVB stage engine ignition will occur at approximately 144 sec after liftoff and engine cutoff will occur when the conditions of vehicle velocity and altitude are such that after end of thrust decay the vehicle will be in an 85 to 120 nmi elliptical orbit. This will occur at approximately 599 sec after liftoff. The vehicle will be maintained at a constant inertial attitude to minimize cutoff attitude transients from 2 sec prior to S-IVB cutoff to orbit insertion.

Immediately after insertion, the S-IVB will pitch the S-IVB/IU/SC combination 0.5 deg/sec until establishment of a zero degree attitude between its roll axis and the local horizontal. Following completion of this maneuver, an average orbital rate will be imparted to maintain the roll axis parallel to the local horizontal. At approximately 50 min after insertion, the S-IVB will inertially stabilize the vehicle for 7 min to allow normal LM separation. After the 7 min hold, the S-IVB will return the spacecraft to the local horizontal attitude for 40 min and will again inertially stabilize the configuration for 7 min to allow backup LM separation from the S-IVB/IU, after which the S-IVB will orient itself in a retrograde attitude with respect to the local horizontal by maneuvering at 0.5 deg/sec. After the retrograde attitude is attained, the average orbital rate will again be established to maintain the roll axis parallel to the local horizontal for the remainder of the mission.

After separation from the S-IVB/IU, the LM will continue for nine orbits to evaluate LM subsystem operation, during which descent propulsion system burns and ascent propulsion system burns will be performed. An ascent propulsion system fire-in-the-hole abort test will be conducted; and several orbit transfer tests will also be performed by the LM/ascent propulsion system during the remaining orbits.

Tables 2-1 through 2-4 present a flight mass summary and DAC predicted trajectory parameters at significant times. Figures 2-2 and 2-3 present graphical representations of predicted S-IB and S-IVB flight trajectories.

The trajectory information presented in this section is based on MSFC Memorandum R-AERO-DAP-66-66 "AS-206 Revised Reference Trajectory," dated 22 July 1966 and does not reflect the changes in trajectory due to the final propulsion predictions presented in appendix 5. Therefore, some of the sequence of event times presented in table 2-1, appendix 2, and appendix 5 are not compatible with the trajectory information. This is also applicable to the flight times presented in appendix 1.

20 December 1966

TABLE 2-1
 PREDICTED S-IVB-206 STAGE FLIGHT MASS SUMMARY

TABLE 2-1
 PREDICTED S-IVB-206 STAGE FLIGHT MASS SUMMARY

ITEM	LIFTOFF	S-IB/S-IVB SEPARATION	S-IVB ESC	S-IVB 90 PERCENT THRUST	EMR CUTBACK	S-IVB ECC	S-IVB ETD*	NOSE CONE SEPARATION	LM SEPARATION
Aft frame	31	0	0	0	0	0	0	0	0
Detonation package	5	0	0	0	0	0	0	0	0
Frost	100	0	0	0	0	0	0	0	0
Ullage rocket grain	176	171	107	0	0	0	0	0	0
Ullage rocket case	214	214	214	214	0	0	0	0	0
Nose cone	1,400	1,400	1,400	1,400	1,400	1,400	1,400	0	0
SLA ring	75	75	75	75	75	75	75	75	0
LM	33,500	33,500	33,500	33,500	33,500	33,500	33,500	33,500	0
Adapter	3,625	3,625	3,625	3,625	3,625	3,625	3,625	3,625	3,625
Instrument unit	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Experiment No. 2	150	150	150	150	150	150	150	150	150
S-IVB-206 dry stage	21,676	21,676	21,676	21,676	21,676	21,676	21,676	21,676	21,676
LOX ullage gas	40	40	40	43	275	392	394	542	542
LOX in tank	192,906	192,906	192,906	192,319	57,910	2,774	2,645	2,613	2,587
LOX in ports	13	13	13	13	13	13	13	13	13
LOX in lines	246	246	246	246	246	246	246	246	246
LOX in engine	108	108	108	108	108	108	108	108	108
LOX below valve	0	0	0	30	30	30	0	0	0
LH2 ullage gas	189	189	189	191	328	460	460	380	380
LH2 in tank	37,588	37,588	37,588	37,445	13,059	1,446	1,419	1,139	914
LH2 in lines	38	38	38	38	38	38	38	38	38
LH2 in engine	10	10	10	10	10	10	10	10	10
LH2 below valve	0	0	0	10	10	10	0	0	0
Cold helium quad 1	86	86	86	86	59	48	48	48	48
Cold helium quad 2	172	172	172	171	119	96	96	96	96
APS propellants fin plane I	64	64	64	64	62	61	61	61	61
APS propellants fin plane III	64	64	64	64	62	61	61	61	61
APS helium	3	3	3	3	3	3	3	3	3
Hydraulic oil	15	15	15	15	15	15	15	15	15
N2 Hydraulic reservoir	2	2	2	2	2	2	2	2	2
Air hydraulic pump	1	1	1	1	1	1	1	1	1
Helium engine pneumatics	3	3	3	3	3	3	3	3	3
Helium vehicle pneumatics	1	1	1	1	1	1	1	1	1
GH2 start tank	5	5	5	1	7	7	7	7	7
Environmental control fluid	14	14	14	14	14	14	14	14	14
Total mass (lbm)	296,519	296,379	296,314	295,517	136,800	70,264	70,070	68,426	34,600
Time from liftoff (sec)	0.0	142.5	143.9	147.2	438.9	586.4	587.7	2,000.0	3,124.8

* End of thrust decay

TABLE 2-2
 PREDICTED CONDITIONS AT AS-206 MAXIMUM DYNAMIC PRESSURE

PARAMETER	UNITS	PREDICTED
Flight time (t)	sec	75
Dynamic pressure (q)	lbf/ft ²	740
Altitude (h)	ft	41,929
Angle of attack (α)	deg	0.03

TABLE 2-3
 PREDICTED CONDITIONS AT AS-206 S-IB/S-IVB SEPARATION

PARAMETER	UNITS	PREDICTED
Flight time (t)	sec	142
Inertial velocity (V_I)	ft/sec	7,937
Inertial flight path elevation angle (V_{1I})	deg	22.5
Inertial azimuth	deg	75
Angle of attack (α)	deg	2.3
Altitude (h)	ft	185,367

TABLE 2-4
 PREDICTED CONDITIONS AT S-IVB CUTOFF

PARAMETER	UNITS	PREDICTED
Flight time (t)	sec	599
Inertial velocity (V_I)	ft/sec	25,685
Inertial flight path elevation angle (V_{1I})	deg	0.00
Inertial azimuth	deg	86.0
Angle of attack (α)	deg	4.4
Altitude (h)	ft	535,531

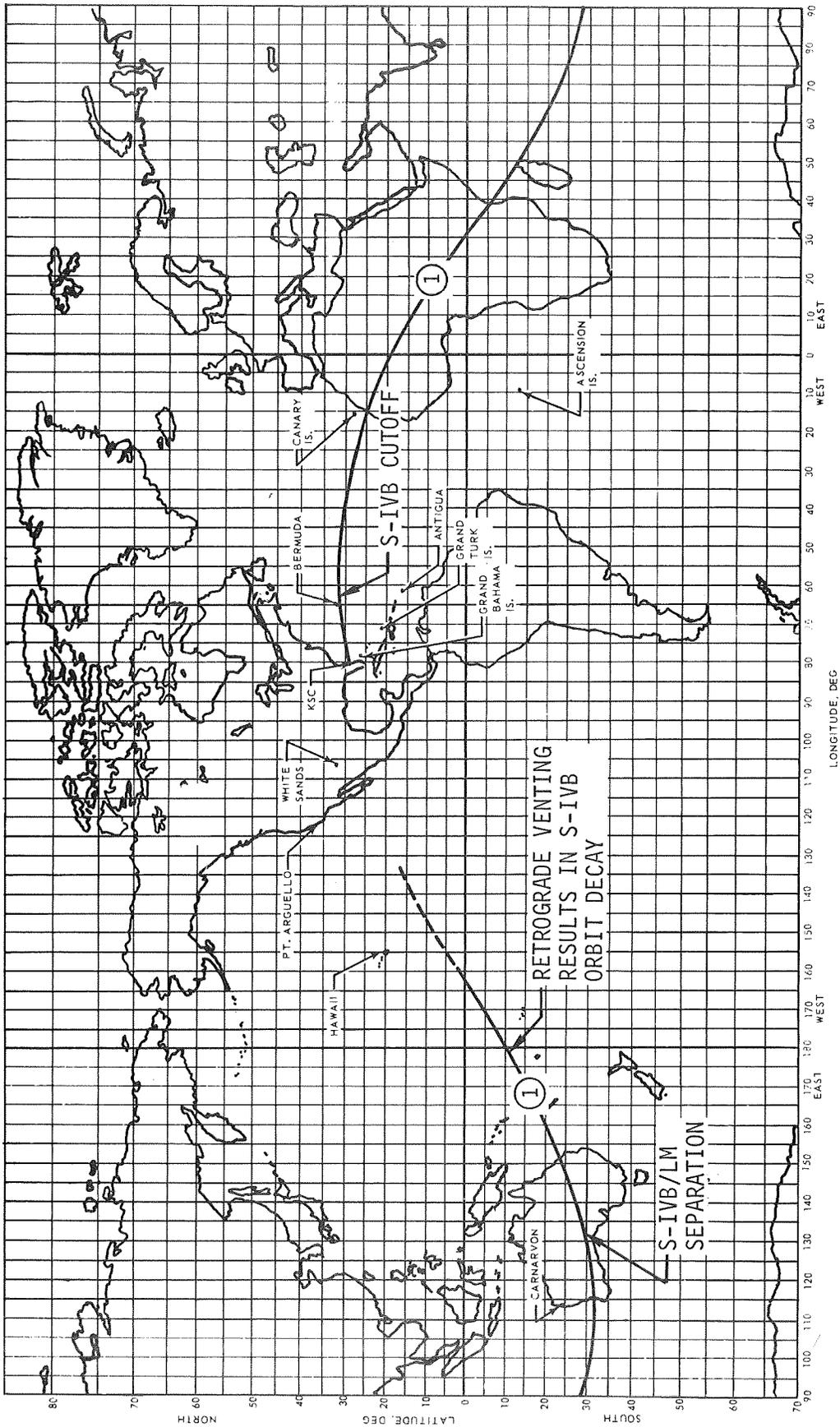


Figure 2-1. AS-206 Ground Trace

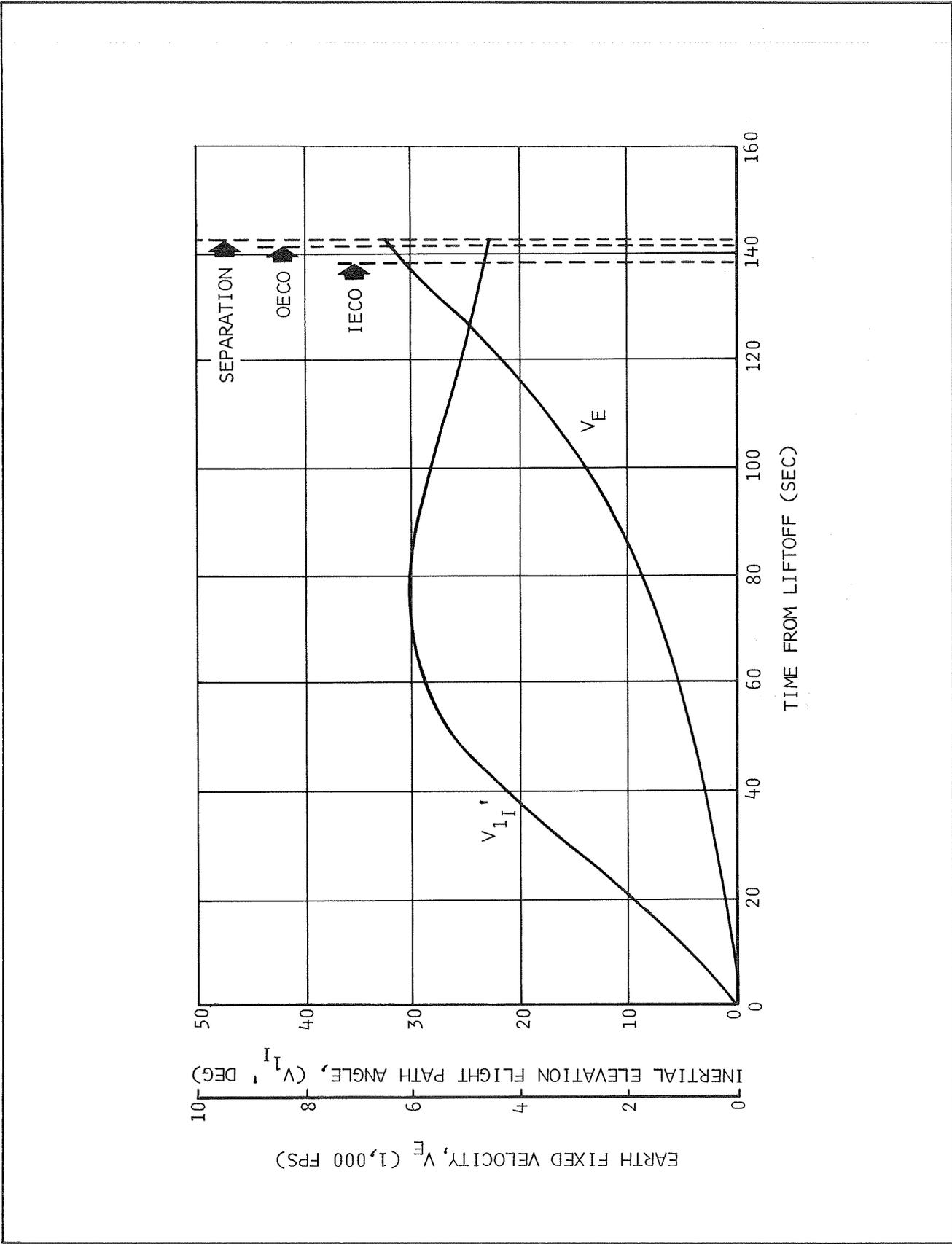


Figure 2-2. Predicted S-IB Stage Flight Trajectory (Sheet 1 of 3)

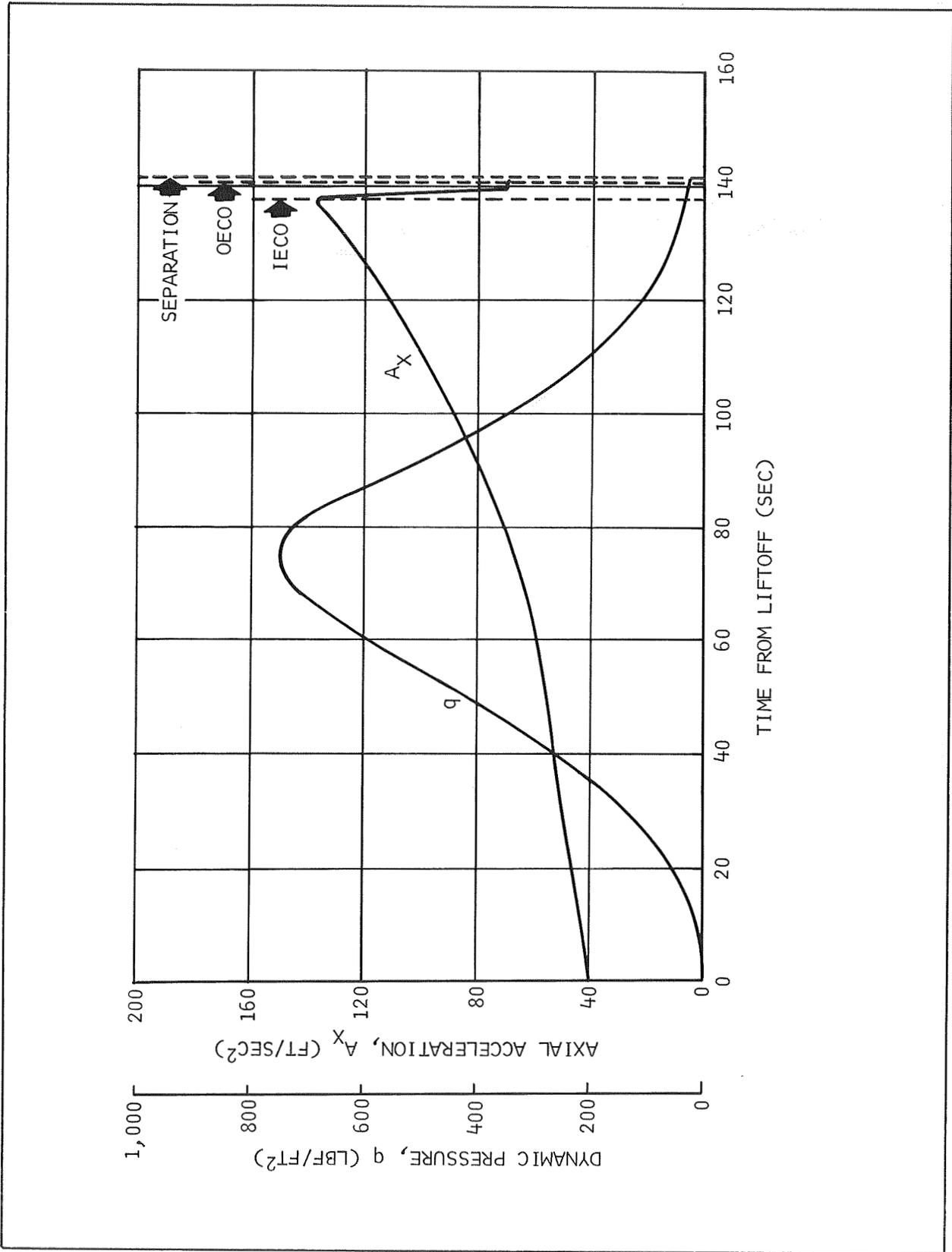


Figure 2-2. Predicted S-IB Stage Flight Trajectory (Sheet 2 of 3)

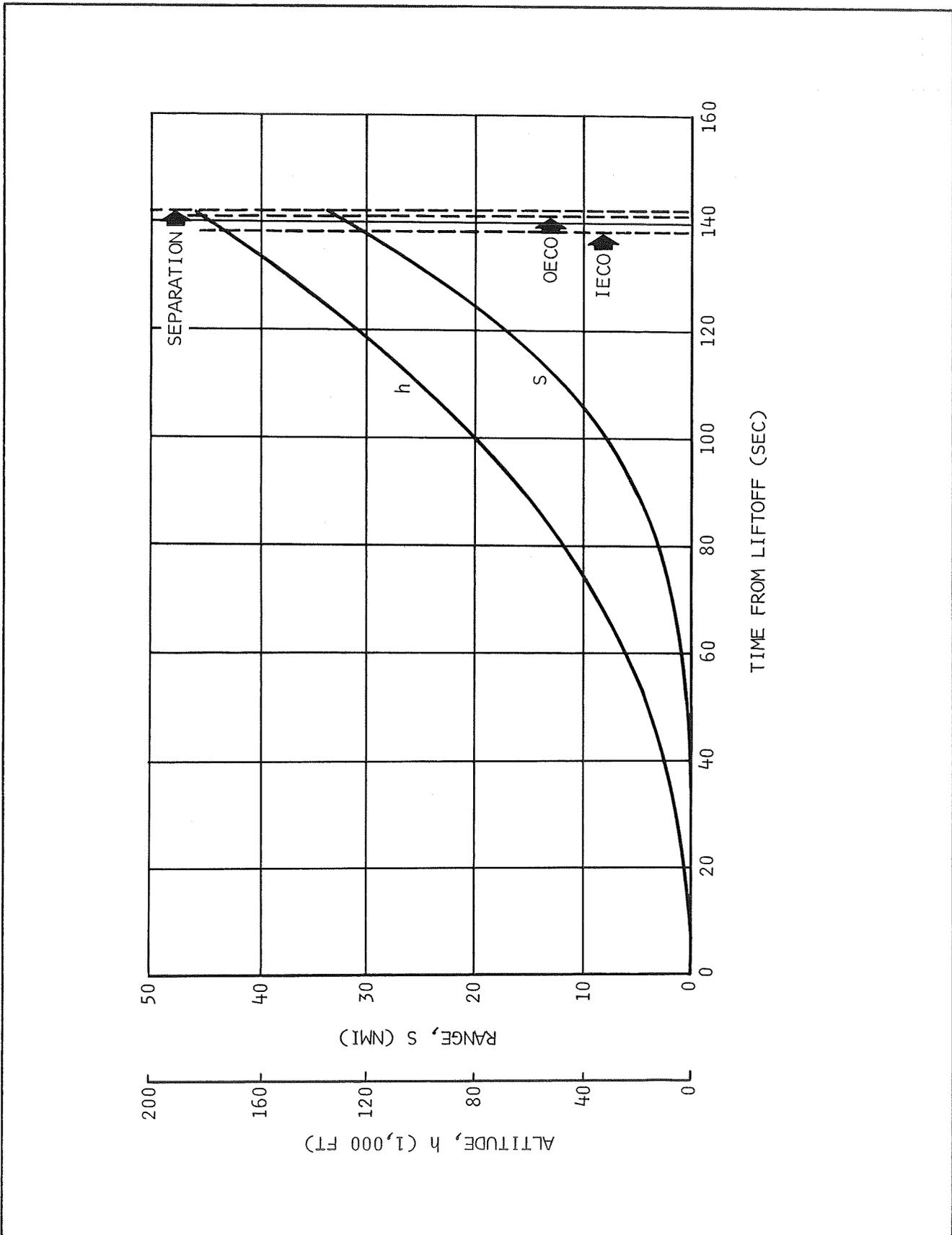


Figure 2-2. Predicted S-IB Stage Flight Trajectory (Sheet 3 of 3)

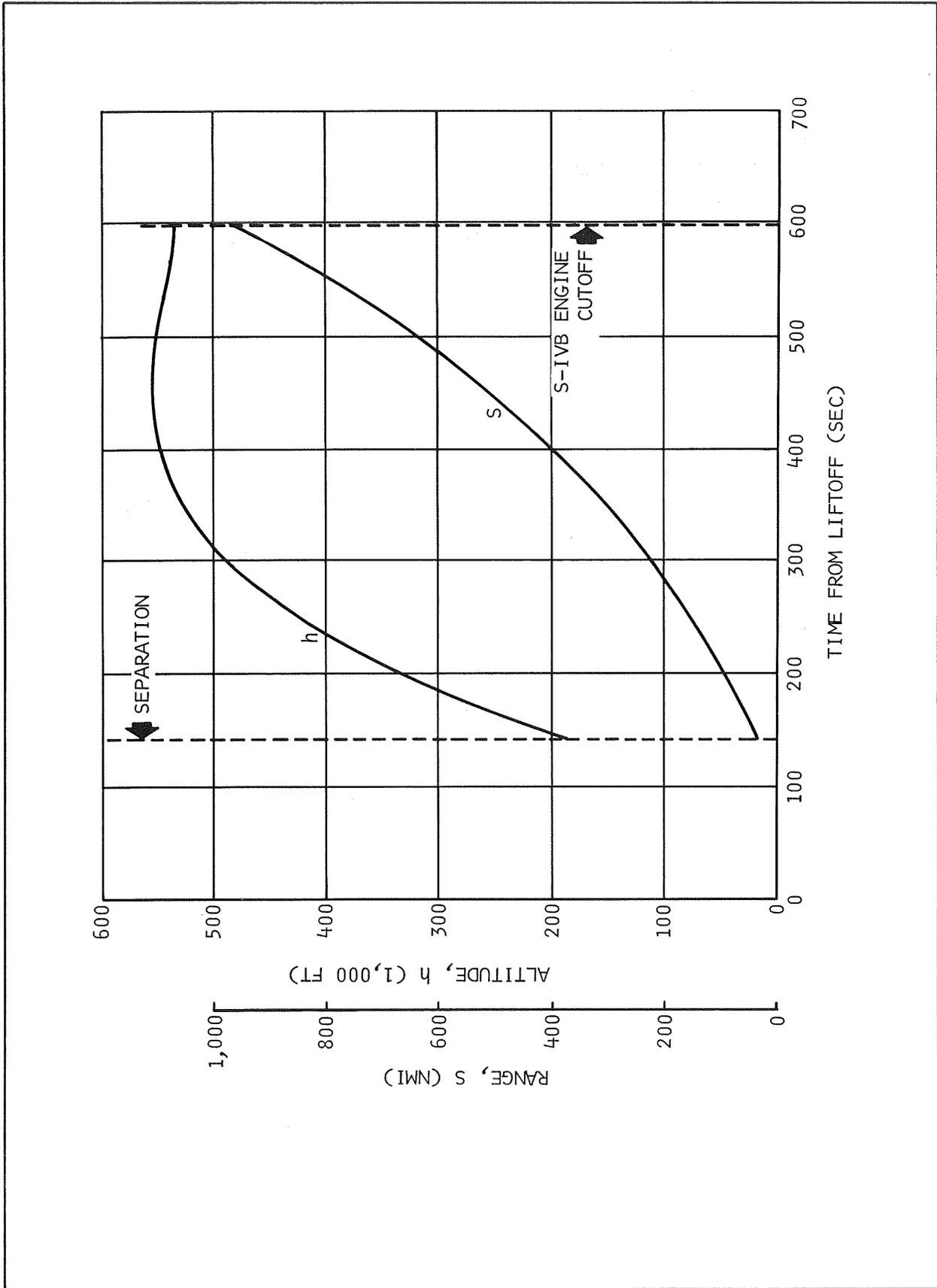


Figure 2-3. Predicted S-IVB Stage Flight Trajectory (Sheet 1 of 2)

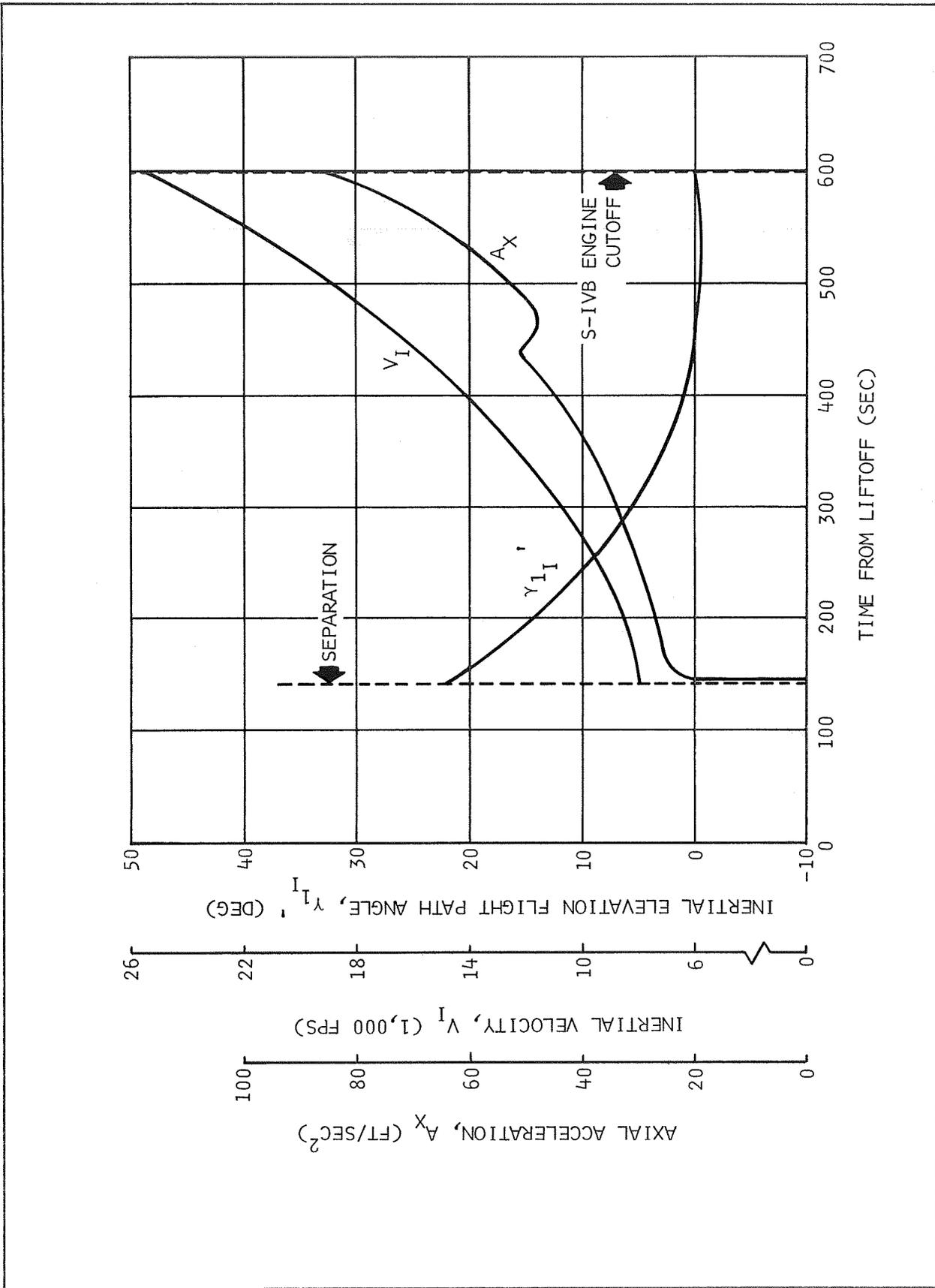


Figure 2-3. Predicted S-IVB Stage Flight Trajectory (Sheet 2 of 2)

3. STAGE OBJECTIVES

This section defines the S-IVB stage powered flight and orbital objectives of the AS-206 mission. The stage objectives describe the evaluation to be accomplished exclusively by DAC and do not completely satisfy the mission objectives presented in section 2. These will be satisfied by the cumulative evaluation efforts of MSFC, DAC, and other Saturn program contractors and reported in the MSFC vehicle report.

The purpose of the S-IVB stage objectives is to verify the adequacy of the performance of the S-IVB-206 stage airframe and systems.

3.1 Structural Airframe

Verify the structural integrity of the S-IVB stage during all phases of the mission. This objective will be achieved in postflight studies, using available flight data, by evaluating the structural performance of the following components:

- a. Forward skirt assembly
- b. LH2 tank assembly
- c. LOX tank assembly
- d. Engine thrust structure
- e. Aft skirt assembly
- f. Aft interstage assembly
- g. Common bulkhead

3.2 Main Propulsion System

Verify the main propulsion system operations during prelaunch, launch, boost, and powered flight. This objective will be achieved by evaluation of the following: J-2 engine, LH2 system, LOX system, and pneumatic control and purge systems. Predicted propulsion system performance curves are presented in figures AP 5-1 through AP 5-31. Predicted propulsion system performance parameters are presented in table AP 5-1.

3.2.1 J-2 Engine Performance and Conditioning

Determination of the performance characteristics of the J-2 engine will be verified by evaluating the:

- a. Engine thrust chamber
 - (1) Chilloidn time
 - (2) Thermal gradients
- b. Response of associated structure to engine chilloidn
- c. S-IB/S-IVB interstage environment
- d. Engine start sphere
 - (1) Chilloidn and loading
 - (2) Conditions in sphere at liftoff and Engine Start Command
 - (3) Mass used for engine start
 - (4) Warmup rate from pressurization to liftoff and during S-IB boost
- e. Engine control helium sphere
 - (1) Prepressurization and loading
 - (2) Conditions at liftoff and Engine Start Command (ESC)
 - (3) Warmup rate from liftoff and during S-IB boost
- f. Retro and ullage rocket plume impingment effect on engine during S-IB separation
- g. Engine sequencing
- h. Thrust buildup characteristics during engine start transient
- i. Thrust characteristics during steady-state operation
- j. Thrust decay characteristics following Engine Cutoff Command
- k. Total impulse
- l. Start impulse
- m. Cutoff impulse
- n. Propellant consumption using flow integration and the thrust profile for flight performance reconstruction
- o. Engine horsepower extraction during mainstage.

3.2.2 LH2 System

Demonstration of the satisfactory operation of the LH2 propellant feed system and the LH2 vent system will be verified by:

- a. LH2 propellant feed system
 - (1) Sufficient fuel and net positive suction head (NPSH) to the J-2 engine for satisfactory operation
 - (2) Loading rates and tank ullage pressure to satisfy prelaunch loading operation requirements
 - (3) Prepressurization of the LH2 tank prior to launch
 - (4) Transition from ground prepressurization to onboard flight pressurization system to provide tank ullage pressure during engine operation
 - (5) Conditions of propellant supplied to the J-2 engine LH2 pump inlet during prestart and steady-state operation
 - (6) LH2 recirculation chilldown
 - (7) NPSH delivered to the J-2 engine interface
- b. LH2 vent system
 - (1) Required tank pressures after J-2 engine cutoff
 - (2) Nonpropulsive vent (NPV) system flowrate
 - (3) NPV system thrust and thrust imbalance
 - (4) Tank depressurization rate
 - (5) Heat input rates.

3.2.3 LOX System

Demonstration of the capability of the oxidizer system to provide sufficient oxidizer and NPSH to the J-2 engine for satisfactory operation will be verified by:

- a. Loading rates and tank ullage pressure to satisfy prelaunch loading requirements
- b. Prepressurization of the oxidizer tank prior to launch

- c. Transition from ground prepressurization to onboard flight pressurization to provide tank ullage pressure during engine operation
- d. Pressurization control module operation
- e. Cold helium supply
- f. J-2 heat exchanger performance
- g. LOX pump chilldown and recirculation
- h. Conditions of LOX supplied to the engine pump inlet during prestart and steady-state operation
- i. NPSH delivered to the J-2 engine interface
- j. LOX boiloff
- k. Tank depressurization rate following J-2 engine shutdown and vent valve actuation.

3.2.4 Pneumatic Control and Purge System

Demonstration of the capability of the pneumatic control and purge system to provide pneumatic power and purge gas throughout the mission will be verified by:

- a. The ambient helium supply
- b. The regulation of control pressure
- c. Actuation of pneumatic valves
- d. Helium purge pressure and flow for the LH2 and LOX turbopump purges during prelaunch operations
- e. LOX recirculation chilldown pump motor container purge pressure.

3.3 Propulsion System Performance

Verification of the compatibility of the observed trajectory and S-IVB propulsion system performance will be achieved by determining the following from trajectory data:

- a. S-IVB stage thrust, specific impulse, and mass flow

- b. Vehicle mass at ignition and cutoff
- c. S-IVB stage thrust vector misalignment.

3.4 Auxiliary Propulsion System

Verify the ability of the auxiliary propulsion system (APS) to provide thrust on demand for roll control during S-IVB J-2 engine burn, and pitch, yaw and roll control for the remainder of the mission. This will be determined by evaluation of the:

- a. Propellant loading rates and the ullage and propellant tank pressures during loading operations
- b. Loading rate for the helium supply sphere
- c. Pressurization of the propellant tanks to flight pressure
- d. Response of the engines to stage commands during preflight checkouts and powered flight
- e. Value of the minimum impulse bit
- f. APS system performance in space environment.

3.5 Ullage Rockets

Verify the capability of the ullage rockets to provide sufficient thrust for propellant stabilization during separation and the J-2 engine start transient. This will be verified by evaluation of the:

- a. Response of ullage rockets to ignition signal
- b. Proper jettisoning.

3.6 Retrorockets

Verify the capability of the retrorockets to provide sufficient thrust for S-IB/S-IVB separation. This will be done by determining:

- a. Response of retrorockets to ignition signal
- b. Chamber pressure versus time.

3.7 Hydraulic System

Verification of the hydraulic system performance during powered flight. This objective will be achieved by:

- a. Determining that adequate pressurized fluid flow was available to the servo-actuator and that hydraulic system pressures were maintained within expected limits (figure AP 8-1)
- b. Verifying that the fluid temperature was maintained within acceptable limits during system operation (figure AP 8-1)
- c. Verifying the adequacy of actuator artificial damping mechanism performance
- d. Determining the magnitude of IU command errors just prior to switching guidance to S-IVB burn mode
- e. Evaluating the adequacy of present compensation for thrust vector deflection errors caused by the manufacturer's tolerance in the gimbal and thrust structural compression effects
- f. Verifying proper pitch and yaw actuator responses to commands.

The temperature of the hydraulic system auxiliary pump, the air bottle pressure, and reservoir level will be monitored during coast. Also during coast the following will be evaluated:

- a. The magnitude of IU command errors in the S-IVB non-burn mode
- b. Actuator deflections.

3.8 Flight Control Systems

Verification of the proper operation of flight control systems during powered flight and orbital coast will be achieved by: verification of the proper operation of the thrust vector control system and the auxiliary attitude control system, and comparison of the propellant sloshing frequencies with those predicted (figure AP 7-3).

3.8.1 Thrust Vector Control System

Demonstration of the proper performance of the main engine control system during S-IVB powered flight will be achieved by evaluation of the following:

- a. Response of the thrust vector control loop to commands from the guidance control computer
- b. Proper response of the shaping networks and servo-amplifier to commands from the data adapter
- c. Demonstrate overall control stability during S-IVB flight, including controllability immediately after separation
- d. Simulation of transient regions of flight.

3.8.2 Auxiliary Attitude Control System

Verification of control system stability and evaluation of performance during S-IVB powered flight and orbital coast will be achieved by consideration of the following:

- a. Simulation of actual APS firings and attitude errors
- b. Comparison between theoretical and actual control system phase planes
- c. Comparison between actual and allocated impulse usage for vehicle maneuvers and disturbances.

3.9 Stage Separation

Verify clearance distance between stages during separation. Predicted stage separation distance and probability of successful operation are presented in figures AP 7-6 and AP 7-7.

This objective will be achieved by determining the following:

- a. Lateral clearance between stages
- b. Separation distance history between stages
- c. Causes of observed motion by simulation of stage attitude rates and accelerations.

3.10 Data Acquisition System

Verify that the data acquisition system performed within design tolerances. The achievement of this objective will be verified by evaluation of data and of the performance of the following:

- a. Radio frequency (RF) system
- b. Telemetry system
- c. Instrumentation system
- d. Data validity.

3.10.1 RF System

Verify the proper operation of the RF system by evaluation of the following:

- a. RF signal strength at ground stations, horizontal and vertical polarization energy of each of the RF frequencies to determine radiated power
- b. RF power output of the transmitter assembly measured by means of directional couplers and RF power detectors
- c. Voltage standing wave ratio (VSWR) computed from forward and reflected power data obtained from the bi-directional coupler and RF power detectors
- d. Effect of flame attenuation by measuring signal strength at ground stations and computing the signal attenuation.

3.10.2 Telemetry System

Verify the telemetry subsystem performance. The achievement of this objective will be verified by consideration of the following:

- a. Verification of the compatibility of the data format, signal synchronization, and system calibrations with the data reduction equipment utilizing prelaunch data. During flight, checks are made to determine synchronization between data reduction systems and incoming data

- b. Examination of PCM data channels and synchronization words to verify consistency and proper operation of ground equipment.

3.10.3 Instrumentation System

Verify the performance of the instrumentation system. The achievement of this objective will be verified by evaluating the following:

- a. Pulse code modulation (PCM) data for proper format
- b. The system response to calibration commands.

3.10.4 Data Validity

Verify the validity of data from the digital data acquisition system (DDAS). The achievement of this objective will be established by determination of data validity on a channel-by-channel basis from the PCM/DDAS system.

3.11 Electrical Control System

Verify proper performance of the electrical control system by evaluation of the operation of the following:

- a. Switch selector
- b. Sequencer
- c. Control distributors
- d. Power distributors
- e. Pressure switches
- f. EBW and range safety equipment
- g. Interconnecting cables.

3.12 Propellant Utilization

The system performance will be verified. This will be achieved by evaluating the PU system as utilized in a propellant loading mode and for inflight propellant management as defined by the criteria listed herein. (S-IVB-206 propellant loading data are given in appendix 6.)

- a. Demonstrate that the PU system indicated propellant load is within 1 percent of the actual propellant load in each tank as determined by the statistical weighted average propellant mass history
- b. Demonstrate the ability of the PU system to provide propellant management, and to deplete residuals (within 575 lbm or less usable propellant) as extrapolated from the conditions existing at cutoff
- c. Demonstrate closed-loop PU operation in the programmed mixture ratio (PMR) mode with high engine mixture ratio (EMR) for 280 (+45) sec from Engine Start Command followed by a cutback to a nominal reference mixture ratio of 4.70 for the duration of the powered flight.

3.13 Range Safety System

The performance will be verified by proper operations of the range safety system for normal flight, or for termination of an abnormal flight by the following criteria:

- a. Normal flight
 - (1) An RF carrier should be received by the stage at all times
 - (2) Indication of signal strengths from each range safety receiver should be a nominal 3.0 v.
- b. Abnormal Flight

The operation of the range safety system during an abnormal flight should include those operations described for normal flight (paragraph 3.13a) plus the following:

- (1) Indication of receipt of the propellant dispersion EBW Firing Unit, Arm and Engine Cutoff Command, from the range safety decoder. Tri-level signal from the controller should show a step increase from 1.27 (+0.15) v to 2.43 (+0.3) v

- (2) The EBW firing units should show a charge of 2,300 (+100) v within 1 sec after the receipt of the EBW arm and engine cutoff signal
- (3) After a predetermined time from the arm and engine cutoff signal, the range safety decoder will give a Propellant Dispersion Command to the vehicle. At this time the controller tri-level signal should show a step increase to 3.16 (+0.45) v.

3.14 Ordnance System

Verify proper operation of the ordnance system during powered flight. The verification will be achieved by evaluation of the following:

- a. Operation of the stage separation system
- b. Operation of the ullage rocket ignition and jettison systems
- c. Operation of the retrorocket ignition system.

3.15 Environmental Control System

Proper environmental control system performance verification will be determined during powered flight and coast by:

- a. Determine that proper thermoconditioning fluid flowrate, supply pressure and temperatures were maintained by the IU
- b. Determining that proper thermoconditioning system fluid return pressure and temperature were within normal operating ranges.

3.16 Stage Aerodynamics and Thermodynamics

Verify the aerodynamic/thermodynamic performance of the S-IVB stage, as feasible, during launch, boost, powered flight and orbit. This will be achieved by utilizing trajectory, relevant telemetry and other data pertinent to the following areas:

- a. Forward and aft compartment venting
- b. Stage heating

- c. Liquid hydrogen heating
- d. Component thermal environment.

3.17 Stage Sequence of Events

Determination of the proper S-IVB acknowledgement of sequence commands issued from the IU will be verified by comparing IU command times to stage monitored command times.

3.18 Countdown Demonstration Test

The objective of the countdown demonstration test, relevant to flight, will be to verify the propellant utilization system calibration presented in appendix 6.

4. STAGE CONFIGURATION

This section presents the general configuration of the S-IVB-206 stage and the significant configuration differences between S-IVB-206 and S-IVB-205. The Saturn IB AS-206 launch vehicle, including spacecraft LM adapter (SLA) and nose cone configuration, is shown in figure 4-1.

4.1 S-IVB-206 Stage

The S-IVB-206 stage, second stage of the AS-206 launch vehicle, is presented in figure 4-2 and consists of the following assemblies:

- a. Forward skirt
- b. Propellant tanks
- c. Aft skirt
- d. Engine thrust structure
- e. Aft interstage
- f. Supporting subsystems

A detailed description of these assemblies is contained in DAC Drawing No. 1B63904, S-IVB-206 Stage End Item Test Plan (reference 4).

The main stage propulsion system schematic is shown in figure 4-3 and the data acquisition system in figure 4-4. The propellant utilization (PU) system forward and feedback shaping networks are shown in figure 4-5.

4.2 Stage Configuration Differences

This paragraph delineates significant configuration differences between the S-IVB-206 and S-IVB-205 stages. Since both will be operational stages, the configuration changes and/or differences have been kept at a minimum.

4.2.1 Cold Helium Spheres

The helium spheres located in the LH2 tank have been reduced in number from eight to six. This was accomplished to save weight and simplify the system when it was discovered that the volume of eight spheres was not required.

4.2.2 Thrust Structure

The stringers located in the thrust structure were changed on S-IVB-206. This was done to increase the structural strength to eliminate the possibility of buckling the structure in this area.

4.2.3 Forward Skirt Vent Area

Doublers were added to the forward skirt to reduce the vent area from 200 to 150 sq in. Each of the eight vents are equal in area and the aspect ratio of 4:1 was maintained.

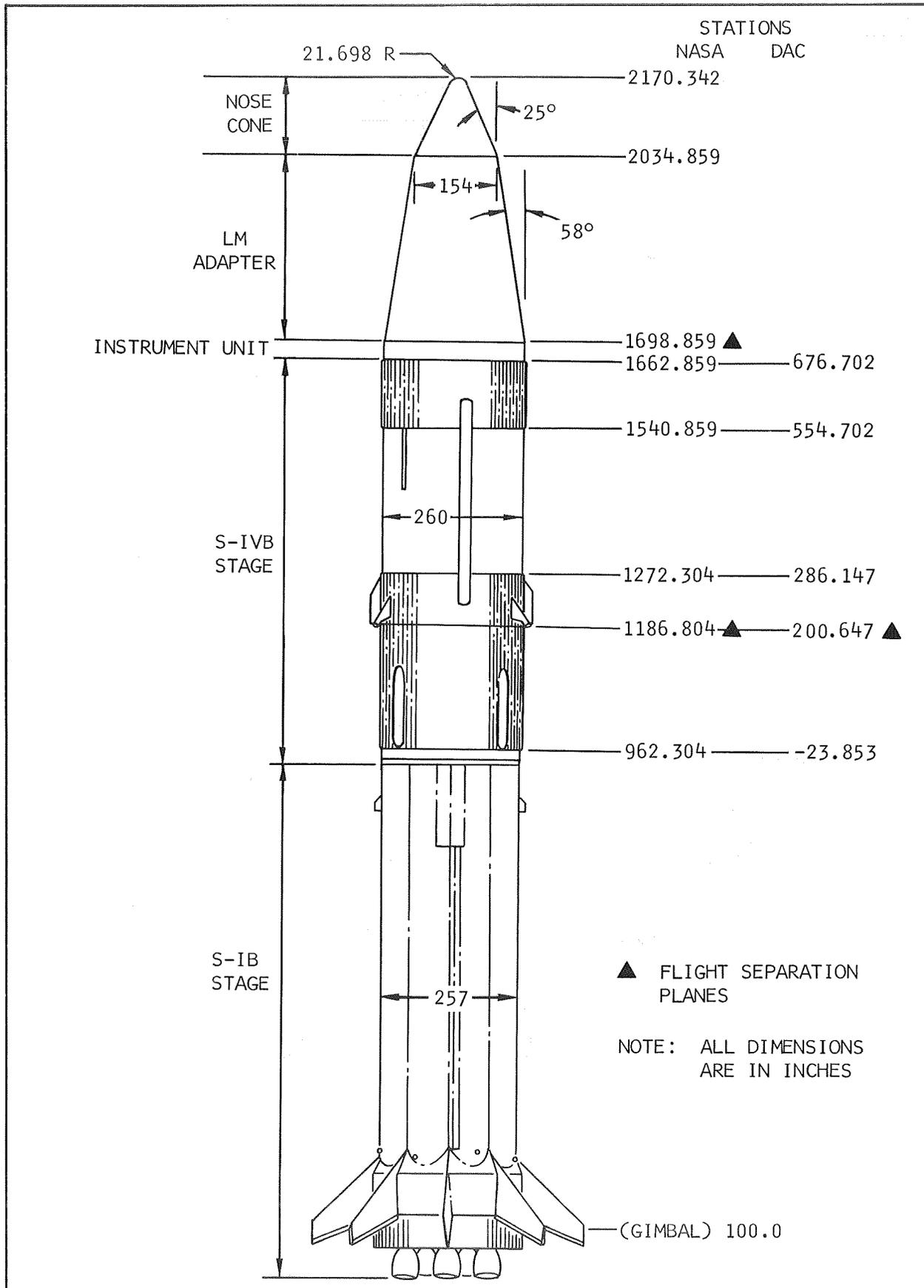


Figure 4-1. AS-206 Launch Vehicle

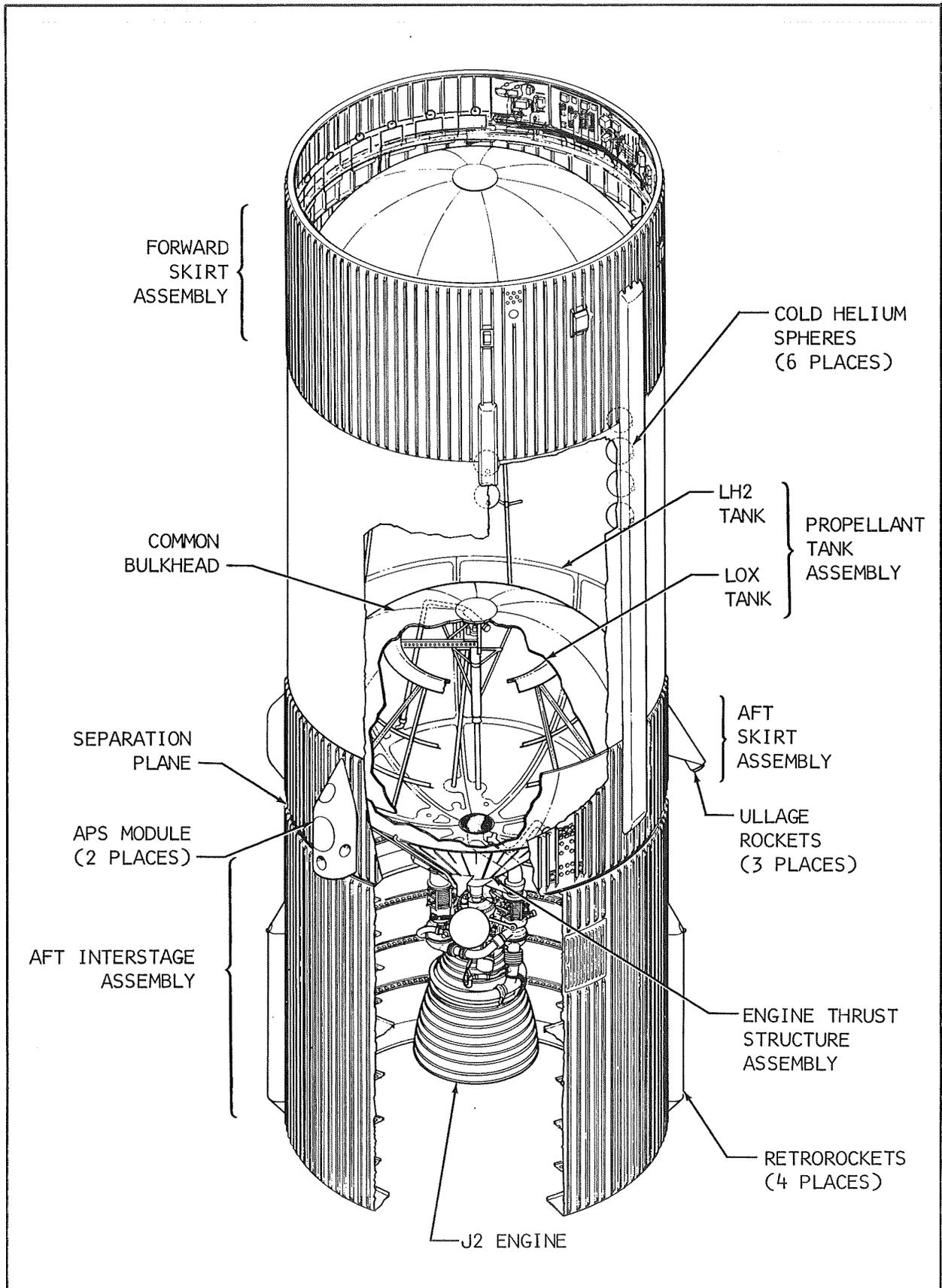
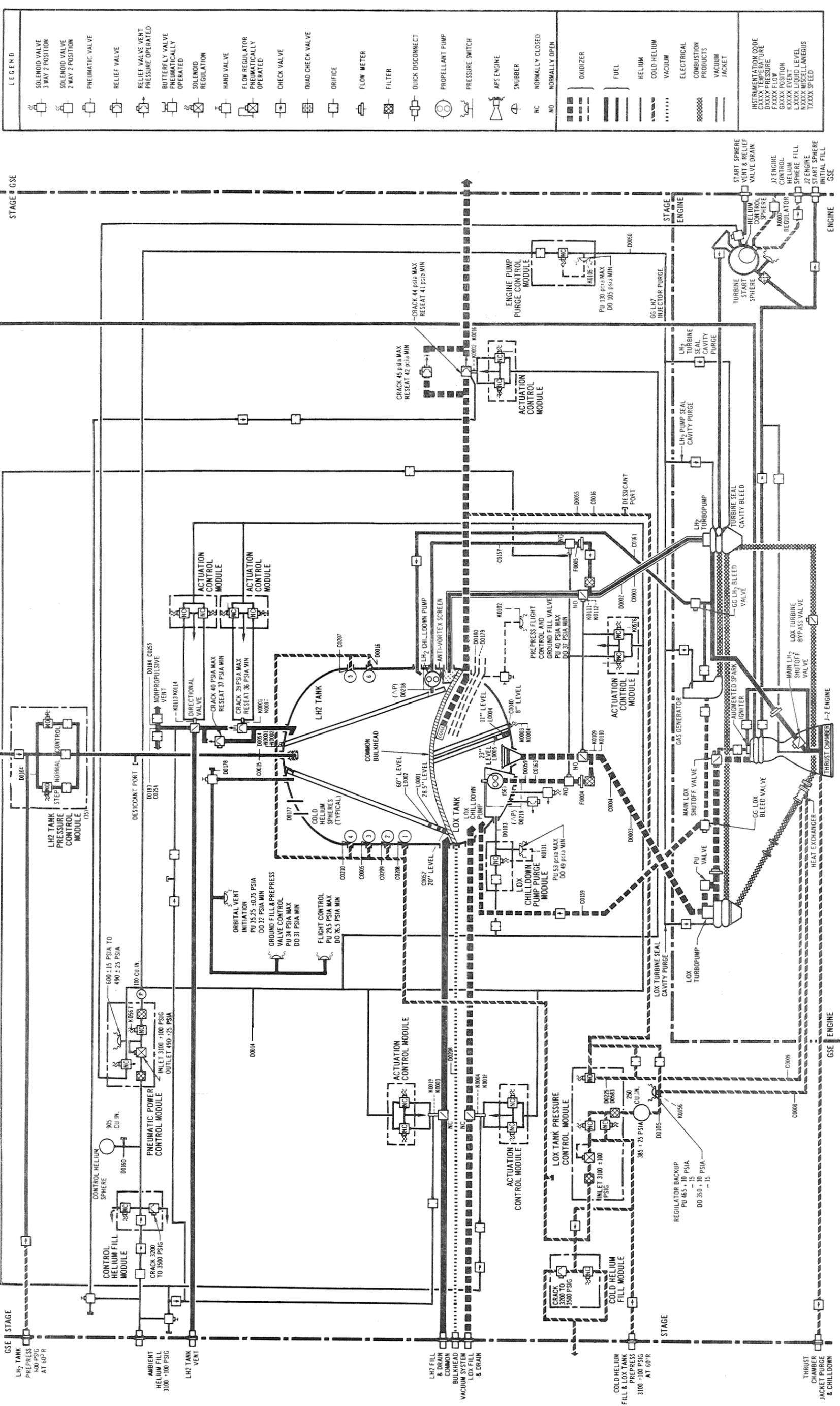


Figure 4-2. S-IVB-206 Stage Cutaway



LEGEND

	SOLENOID VALVE 3 WAY 2 POSITION
	SOLENOID VALVE 2 WAY 2 POSITION
	PNEUMATIC VALVE
	RELIEF VALVE
	RELIEF VALVE VENT PRESSURE OPERATED
	BUTTERFLY VALVE PNEUMATICALLY OPERATED
	SOLENOID REGULATION
	HAND VALVE
	FLOW REGULATOR PNEUMATICALLY OPERATED
	CHECK VALVE
	ORDN CHECK VALVE
	ORIFICE
	FLOW METER
	FILTER
	QUICK DISCONNECT
	PROPELLANT PUMP
	PRESSURE SWITCH
	APS ENGINE
	SNUBBER
	NC NORMALLY CLOSED
	NO NORMALLY OPEN

	OXIDIZER
	FUEL
	HELIUM
	COLD HELIUM
	VACUUM
	ELECTRICAL
	COMBUSTION PRODUCTS
	VACUUM JACKET

INSTRUMENTATION CODE
 CXXXX TEMPERATURE
 PXXXX PRESSURE
 FXXXX FLOW
 GXXXX POSITION
 KXXXX EVENT
 LXXXX LIQUID LEVEL
 NXXXX MISCELLANEOUS
 TXXXX SPEED

Figure 4-3. S-IVB-206 Propulsion System Configuration and Instrumentation

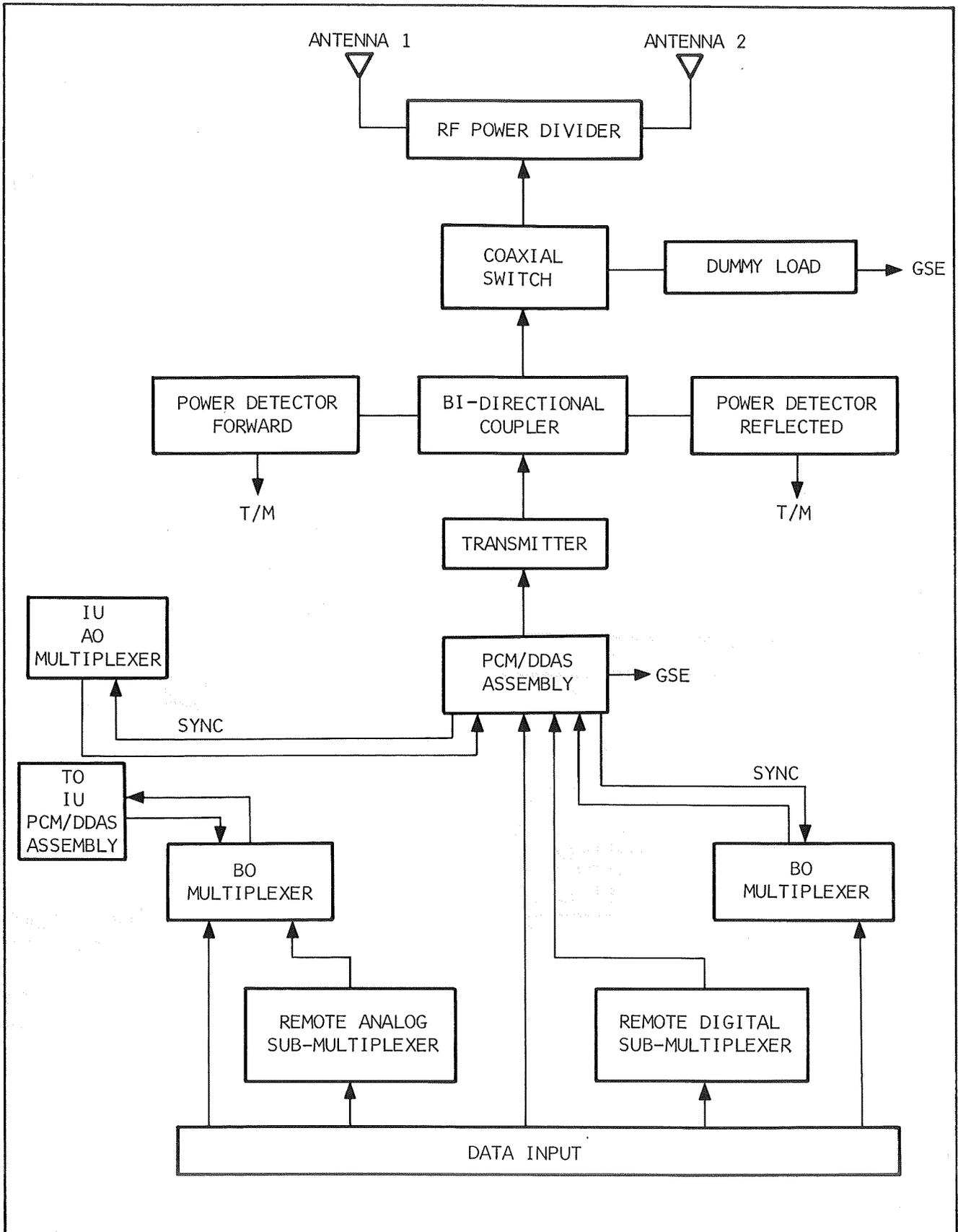


Figure 4-4. Data Acquisition System

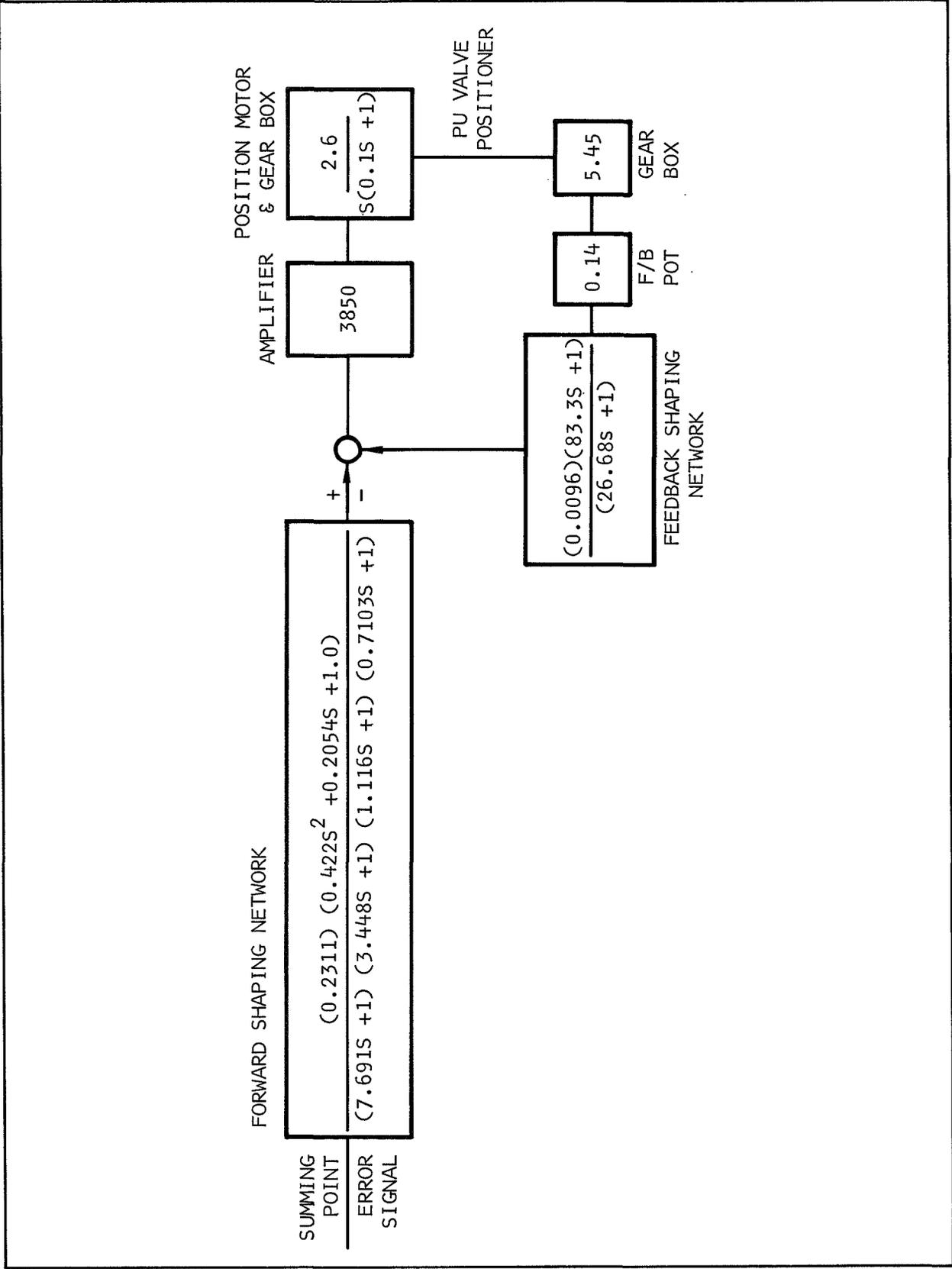


Figure 4-5. S-IVB-206 PU System Block Diagram

5. INSTRUMENTATION

This section delineates the S-IVB flight stage and facility support instrumentation, the redline and blueline prelaunch measurements and the critical telemetry measurements. The primary source for S-IVB prelaunch checkout and countdown data will be the pulse code modulation/digital data acquisition system (PCM/DDAS) (hardwire).

5.1 Flight Stage Measurements

The DAC Instrumentation Program and Components List (IP&CL), reference 5, documents and defines the measurements for the S-IVB-206 stage. These NASA measurement numbers are alphabetically prefixed to identify display parameters and type of measurements, and listed in alphabetical sequence. The following information is also included for each measurement.

- a. Location
- b. Abbreviated title
- c. Range
- d. Flight period of interest
- e. Accuracy
- f. Assigned telemetry channel
- g. Frequency response
- h. Inflight calibration
- i. DAC requesting section
- j. DAC measurement request drawing and change letter
- k. NASA required reference designation
- l. Part numbers of related components.

The IP&CL will be revised as required in accordance with the following plan.

- a. The IP&CL reflects the intended instrumentation program for flight. If a hardware deletion or shortage precludes the possibility of making a measurement, an explanatory note will be added to the IP&CL stating why the measurement cannot be obtained.

- b. Measurements which become inoperative after the countdown demonstration test (CDDT) will not be reflected in the IP&CL. The anomalies will, instead, be reported to the MSFC/FEWG during the course of the normal flight evaluation. There is no opportunity to evaluate every measurement to certify valid instrumentation operation between the CDDT and the launch.

5.2 Redline and Blueline Measurement Requirements

DAC redline and blueline measurement requirements are defined and listed in this section. The parametric limits stated herein do not include allowances for instrumentation errors, tolerances, malfunctions, or inadequacies. The redline and blueline requirements will be continually reviewed and coordinated with the cognizant MSFC laboratories. If the S-IVB stage or mission requirements should change, the redline and blueline requirements will be revised and updated accordingly. It is anticipated that MSFC will take appropriate action to incorporate redline requirements into the Apollo/Saturn IB Launch Mission Rules, AS-206 (reference 6), and the Terminal Count Observer Redline Values (reference 7) documents as in previous flights.

5.2.1 Redlines

A launch redline is the maximum and/or minimum value of a parameter which, if exceeded, shall result in immediate stoppage of the test. A hold must be imposed during the countdown in the event that a redline is exceeded, and the countdown should not be resumed while this condition exists. Redline measurements are mandatory, and the launch countdown should not proceed if a redline measurement is inoperative or incapable of being monitored. Each redline measurement should be monitored on a strip chart recorder in the blockhouse. However, CIF display of some redline measurements is acceptable whenever the launch control center capabilities are exceeded. DAC redlines for S-IVB-206 are presented in table 5-1 and referenced figures. These redlines are also contained in DAC Drawing No. 1B66261, Test Specification and Criteria, KSC Prelaunch Checkout and Launch Operations, S-IVB/IB (reference 8). (Redline data in this document are updated independently of the S-IVB-206 Stage Flight Test Plan because of differing documentation schedules.)

5.2.2 Bluelines

A launch blueline is the maximum and/or minimum value of a parameter which, if exceeded, shall result in an engineering judgment as to whether the test may continue without corrective action. These measurements do not necessarily have to be monitored in the blockhouse, but suitable real-time monitoring must be provided. Blueline measurements are highly desirable as opposed to redlines which are mandatory. Under special circumstances, as determined at the time of the test, failure of a blueline measurement or the exceeding of the blueline limits may preclude continuance of a test. DAC bluelines for S-IVB-206 are presented in table 5-2 and referenced figures.

5.3 Flight Instrumentation System

The flight instrumentation system of the S-IVB-206 consists of the following major elements:

- a. PCM/FM subsystem
- b. RF subsystem
- c. Antenna subsystem
- d. Control calibration command decoder assembly
- e. Channel calibration command decoder assembly
- f. Signal conditioner racks
- g. Transducers
- h. Emergency detection subsystem.

Data inputs are received by the PCM/FM subsystem where the PCM/DDAS phases two multiplexer signals together for an output of 7,200 sps to the RF subsystem and antenna subsystem for transmission to ground support facilities.

5.4 Mandatory Requirements

Since the PCM/FM link (CP-1) is the only telemetry system for the S-IVB-206, it is mandatory that the system performs properly at all times to obtain data for subsequent evaluation.

5.5 Facility Support Instrumentation

Facility support measurements will be delineated in the Facility and Environmental Measuremnts Program (reference 9) to be published by Kennedy Space Center and will include measurement display modes.

20 December 1966

TABLE 5-1 (Sheet 1 of 3)
S-IVB-206 REDLINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	REDLINE LIMITS		EXPECTED VALUE	UNITS	APPLICABLE TIME
		MINIMUM	MAXIMUM			
C0003-403	Temp - Fuel Pump Inlet	Fig 5-1	Fig 5-1	Fig 5-1	deg R	Check at T-15 sec
C0004-403	Temp - Oxid Pump Inlet	--	168	164	deg R	Check at T-2 min, 43 sec
C0006-401	Temp - GH2 Start Bottle	Fig 5-2	Fig 5-2	280	deg R	Check at T-2 min, 43 sec
C0050-401	Temp - Hydraulic Pump Inlet Oil	--	215	30 to 110	deg F	From aux hyd pump thermal (coast) mode ON to T-2 min, 43 sec
C0051-403	Temp - Reservoir Oil (Aux Pump OFF)	Fig 5-3	--	60 to 110	deg F	From aux hyd pump thermal (coast) mode ON until aux hyd pump flight mode ON
C0168-414	Temp - Oxid Tank Out Mod 1 (APS)	535	560	550	deg R	Check at T-15 min
C0169-415	Temp - Oxid Tank Out Mod 2 (APS)	535	560	550	deg R	Check at T-15 min
C0199-401	Temp - Thrust Chamber Jacket	--	265	220	deg R	Check at T-2 min, 43 sec
D0014-403	Press - Control He Reg Discharge	465	615	515	psia	From time of sphere pressurization to T-2 min, 43 sec
D0016-425	Press - Cold Helium Sphere	2,800	3,200	3,000	psia	From T-30 min to T-5 min
D0017-401	Press - GH2 Start Bottle	Fig 5-2	Fig 5-2	1,275	psia	Check at T-2 min, 43 sec
D0019-401	Press - Engine Control He	2,500	3,300	3,100	psia	From time of sphere pressurization to T-2 min, 43 sec
D0041-403	Press - Hyd System (Aux Pump ON)	3,400	4,100	3,550 to 3,650	psia	From aux hyd pump thermal (coast) mode ON to T-10 sec

TABLE 5-1 (Sheet 2 of 3)
S-IVB-206 REDLINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	REDLINE LIMITS		EXPECTED VALUE	UNITS	APPLICABLE TIME
		MINIMUM	MAXIMUM			
D0042-403	Press - Reservoir Oil (Aux Pump Off)	45	--	67 to 89	psia	From aux hyd pump thermal (coast) mode ON to aux hyd pump flight mode ON
D0064-414	Press - Helium Reg Inlet Module 1 (APS)	2,800	3,200	3,000	psia	Check at T-15 min
D0068-415	Press - Helium Reg Inlet Module 2 (APS)	2,800	3,200	3,000	psia	Check at T-15 min
D0094-414	Press - Oxidizer Tank Outlet Module 1 (APS)	203	222	211	psia	Check at T-15 min
D0095-415	Press - Oxidizer Tank Outlet Module 2 (APS)	203	222	211	psia	Check at T-15 min
D0160-403	Press - Helium (Ambient) Sphere	2,800	3,200	3,000	psia	From T-30 min to T-5 min
D0576-408	Press - Fuel Tank Ullage (Hardware)	Fig 5-1	Fig 5-1	Fig 5-1	psia	Check at T-15 sec
D0577-406	Press - Oxid Tank Ullage (Hardware)	37	44	40	psia	Check at T-15 sec
K0013-401	Event - Cutoff Signal	OFF	OFF	OFF		From engine ignition power ON to T-3 sec
K0151-411	Event - PU Oven ON Indication	ON	ON	ON		Immediately before initiation of propellant loading until loading computer lockup.
L0007-403	Level - Reservoir Oil (Aux Pump On) (Aux Pump Off)	8	--	25 to 45	per-cent	From aux hyd pump thermal (coast) mode ON to T-10 sec
M0540-404	Voltage - Aft Bus No. 2	52	61	56	vdc	While on launch vehicle power to T-3 sec. Visual monitoring required. (Backup interlock during automatic sequence is acceptable)
M0541-404	Voltage - Aft Bus No. 1	24	31 (Note 1)	28	vdc	

TABLE 5-1 (Sheet 3 of 3)
S-IVB-206 REDLINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	REDLINE LIMITS		EXPECTED VALUE	UNITS	APPLICABLE TIME
		MINIMUM	MAXIMUM			
M0542-411	Voltage - Fwd Bus No. 2	24	32	28	vdc	While on launch vehicle power to T-3 sec. Visual monitoring required. (Backup interlock during automatic sequence is acceptable)
M0543-411	Voltage - Fwd Bus No. 1	24	32	28	vdc	
N0002-411	Misc - PU System LH2 Fine Mass;	37,448	37,824	37,636	1bm	From T -30 sec to T -10 sec.
	Mass	18,465	18,648	18,557	legs	
N0004-411	Indication - pressurized (Note 2)	192,307	194,239	193,273	1bm	From T -30 sec to T -10 sec.
	Misc - PU System LOX Fine Mass;	19,494	19,685	19,590	legs	

Note 1 - During the initial application of voltage, the maximum allowable voltage may be 32 vdc for a period not to exceed 60 sec.

Note 2 - A leg unit represents about 5 percent of the full mass load. Unpressurized leg values are presented in table 5-2.

TABLE 5-2 (Sheet 1 of 4)
S-IVB-206 BLUELINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	BLUELINE LIMITS		EXPECTED VALUE	UNITS	TIME PERIOD OF BLUELINE APPLICABILITY
		MINIMUM	MAXIMUM			
C0050-401	Temp - Hydraulic Pump Inlet Oil	-10	175	30 to 110	deg F	From aux hyd pump thermal (coast) mode ON until T-2 min, 43 sec
C0102-411	Temp - Fwd Battery No. 1	70	140	90	deg F	After battery is stabilized
C0103-411	Temp - Fwd Battery No. 2	70	140	90	deg F	
C0104-404	Temp - Aft Battery No. 1	70	140	90	deg F	
C0105-404	Temp - Aft Battery No. 2	70	140	90	deg F	
C0166-414	Temp - He Sphere Gas Mod 1 (APS)	510	575	550	Deg R	
C0167-415	Temp - He Sphere Gas Mod 2 (APS)	510	575	550	deg R	Verify at T-15 min
C0170-414	Temp - Fuel Tank Out Mod 1 (APS)	535	560	550	deg R	Verify at T-15 min
C0171-415	Temp - Fuel Tank Out Mod 2 (APS)	535	560	550	deg R	Verify at T-15 min
C0207-425	Temp - Cold He Sphere 5 (Note 1)	-	45	40	deg R	Check at T-2 min 43 sec
D0002-403	Press - Fuel Pump Inlet	37	51	43	psia	Check at T-15 sec
D0003-403	Press - Oxidizer Pump Inlet	48.5	Note 2	52	psia	Check at T-15 sec
D0041-403	Press - Hydraulic Sys (Aux Pump On)	3,500	3,650	3,550 to 3,650	psia	From aux hyd pump thermal (coast) mode ON until T-10 sec
D0042-403	Press - Res Oil (Aux Pump On) (Aux Pump Off)	165	200	169-194	psia	From aux hyd pump thermal (coast) mode ON until T-10 sec
		50	-	67-89	psia	From aux hyd pump thermal (coast) mode ON to flight mode ON

TABLE 5-2 (Sheet 2 of 4)
S-IVB-206 BLUELINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	BLUELINE LIMITS		EXPECTED VALUE	UNITS	TIME PERIOD OF BLUELINE APPLICABILITY
		MINIMUM	MAXIMUM			
D0089-414	Press - Fuel Tank Ullage Module 1 (APS)	203	216	211	psia	Verify at T-15 min
D0090-414	Press - Oxidizer Tank Ullage Module 1 (APS)	203	216	211	psia	Verify at T-15 min
D0091-415	Press - Fuel Tank Ullage Module 2 (APS)	203	216	211	psia	Verify at T-15 min
D0092-415	Press - Oxidizer Tank Ullage Module 2 (APS)	203	216	211	psia	Verify at T-15 min
D0093-414	Press - Fuel Tank Outlet Module 1 (APS)	203	216	211	psia	Verify at T-15 min
D0096-415	Press - Fuel Tank Outlet Module 2 (APS)	203	216	211	psia	Verify at T-15 min
D0545-407	Press - Common Bulkhead Internal	-	5.5	<5.5	psia	Anytime prior to L0
K0012-401	Event - Engine Ready Signal	ON	ON	ON	Signal	T-2 min 43 sec to T-3 sec
K0021-404	Event - Engine Start-ON	OFF	OFF	OFF	Signal	T-2 min 43 sec to T-3 sec
M0001-411	Volt - Static Inverter Converter	110.5	119.5	115	vac	From turn-on to T-3 sec
M0012-411	Freq - Static Inverter Converter	396	404	400	cps	During inverter operation
M0014-404	Volt - Output Aft Battery No. 1	29	36	29.5	vdc	These open circuit voltages should be monitored from battery installation to transfer to internal power
M0015-404	Volt - Output Aft Battery No. 2	64	75	72	vdc	

TABLE 5-2 (Sheet 3 of 4)
S-IVB-206 BLUELINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	BLUELINE LIMITS		EXPECTED VALUE	UNITS	TIME PERIOD OF BLUELINE APPLICABILITY
		MINIMUM	MAXIMUM			
M0016-411	Volt - Output Fwd Battery No. 1	29	36	29.5	vdc	These open circuit voltages should be monitored from battery installation to transfer to internal power
M0018-411	Volt - Output Fwd Battery No. 2	29	36	29.5	vdc	
M0019-411	Current - Load Fwd Battery No. 1	-	50 (58)	40	amps	From transfer to internal power until liftoff (during battery heater operation)
M0020-411	Current - Load Fwd Battery No. 2	-	5	3.5	amps	From transfer to internal power until liftoff
M0021-404	Current - Load Aft Battery No. 1	-	15 (30)	7	amps	From transfer to internal power until liftoff (during battery heater operation)
M0022-404	Current - Load Aft Battery No. 2	-	95	90	amps	From transfer to internal power until liftoff
M0540-404	Volt - 4D41 Bus.	54	60	56	vdc	Anytime power is on
M0541-404	Volt - 4D11 Bus. (X035)	26	30	28	vdc	
M0542-411	Volt - 4D21 Bus. (X040)	26	30	28	vdc	
M0543-411	Volt - 4D31 Bus. (X065)	26	30	28	vdc	
N0002-411	Misc - PU System LH2 Fine Mass: Indication - Unpressurized (Note 3)	18.508	18.691	18.600	legs	From completion of loading until T-2 min, 43 sec
N0004-411	Misc - PU System LOX Fine Mass: Indication - Unpressurized (Note 3)	19.533	19.723	19.628	legs	
N0037-414	Misc-Qty-Oxid Tank Mod 1 (APS)	Fig 5-4	Fig 5-4	9.8 to 9.9	in.	Verify at T-3 hr
N0038-414	Misc-Qty-Oxid Tank Mod 2 (APS)	Fig 5-4	Fig 5-4	9.8 to 9.9	in.	

TABLE 5-2 (Sheet 4 of 4)
S-IVB-206 BLUELINE REQUIREMENTS

MEASUREMENT NUMBER	TITLE	BLUELINE LIMITS		EXPECTED VALUE	UNITS	TIME PERIOD OF BLUELINE APPLICABILITY
		MINIMUM	MAXIMUM			
N0039-414	Misc-Qty - Fuel Tank Mod 1 (APS)	Fig 5-5	Fig 5-5	9.8 to 9.9	in.	Verify at T-3 hr
N0040-415	Misc-Qty - Fuel Tank Mod 2 (APS)	Fig 5-5	Fig 5-5	9.8 to 9.9	in.	Verify at T-3 hr
M0038-307	Volt - 4D110 Bus.	26	30	28	vdc	Anytime respective power is applied
M0043-307	Current - 4D110 Bus.	-	20	10	amps	
M0044-307	Current - 4D111 Bus.	-	15	7	amps	
M0047-307	Volt - 4D210 Bus.	26	30	28	vdc	
M0048-307	Volt - 4D310 Bus.	26	30	28	vdc	
M0053-307	Current - 4D210 Bus.	-	15 Note 4	10	amps	
M0054-307	Current - 4D121 Bus.	-	5	3.5	amps	
M0057-307	Current - 4D131 Bus.	-	50	40	amps	
M0085-307	Volt - 4D410 Bus.	54	60	56	vdc	
M0087-307	Current - 4D141 Bus.	-	110	0 to 90	amps	

NOTE 1: The sequence of events shall be such that the fully pressurized (to D0016-425 Redline limits) cold helium spheres are submerged in LH2 (LH2 tank at least 92 percent full) for at least the last 30 minutes of the countdown prior to liftoff.

NOTE 2: There is no maximum pressure limit for this parameter. The range of D0003 transducer is 0-60 psia. If pressure exceeds 60 psia, use D0557-406 Oxidizer Tank Ullage Pressure (Redline parameter) as abort criteria.

NOTE 3: A leg unit represents approximately 5 percent of the full mass load. Unpressurized leg values are provided only as a starting point for the KSC countdown demonstration test (CDDT). Final leg values will be supplied by DAC/FTC after the CDDT.

NOTE 4: 40 amps during Remote Analog Calibration System (RACS).

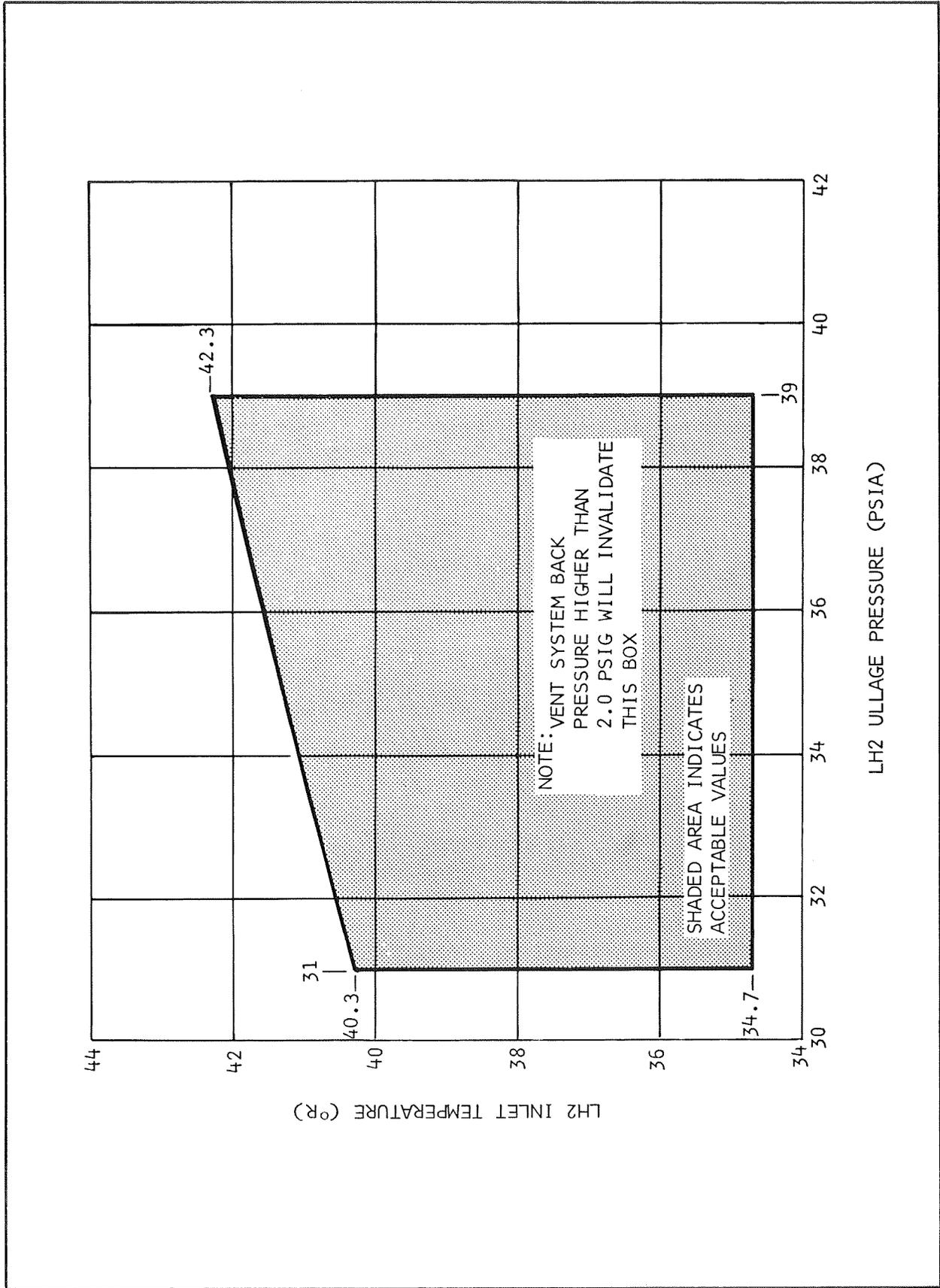


Figure 5-1. LH2 Critical Limits

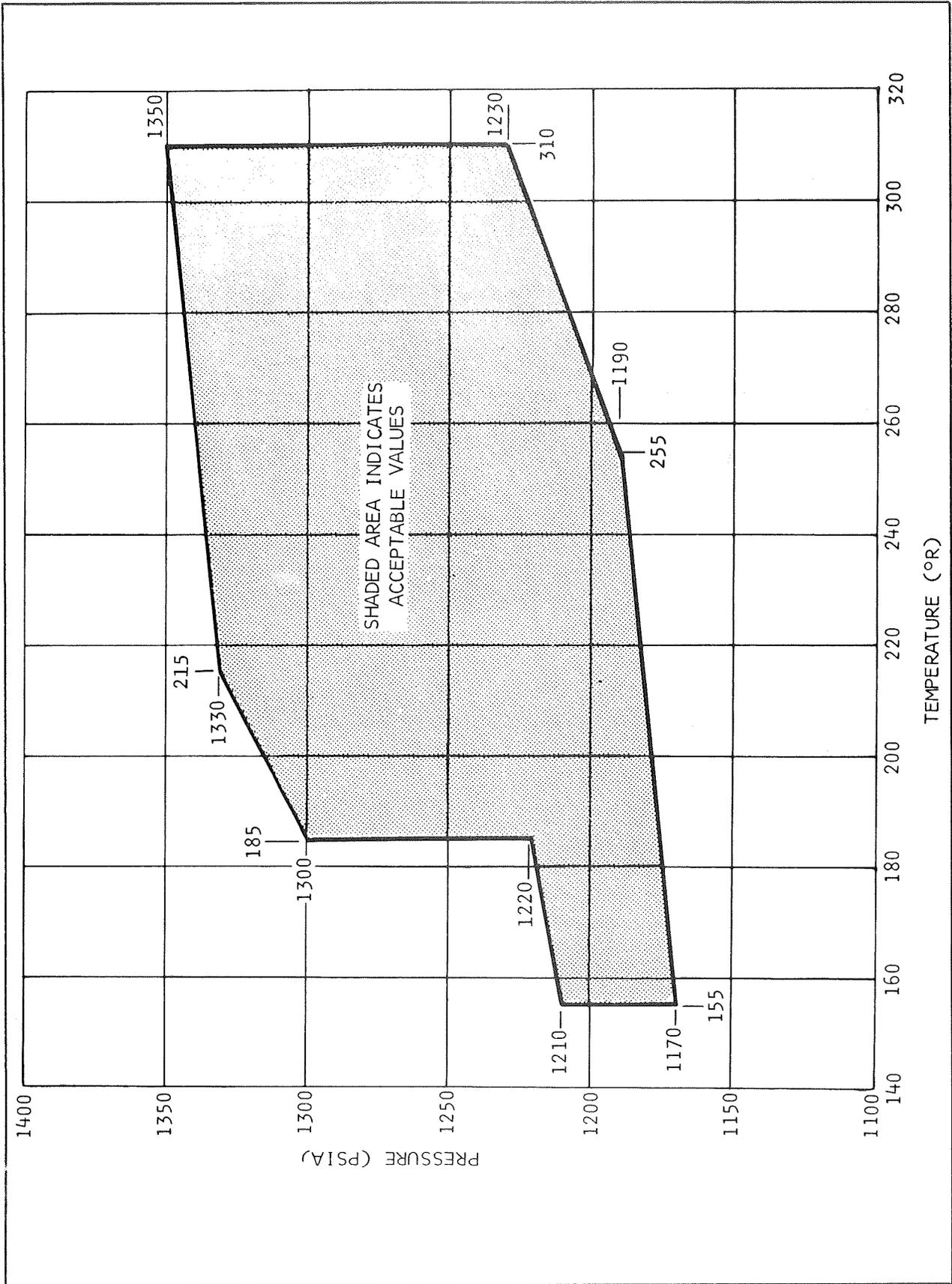


Figure 5-2. GH2 Start Bottle Critical Limits

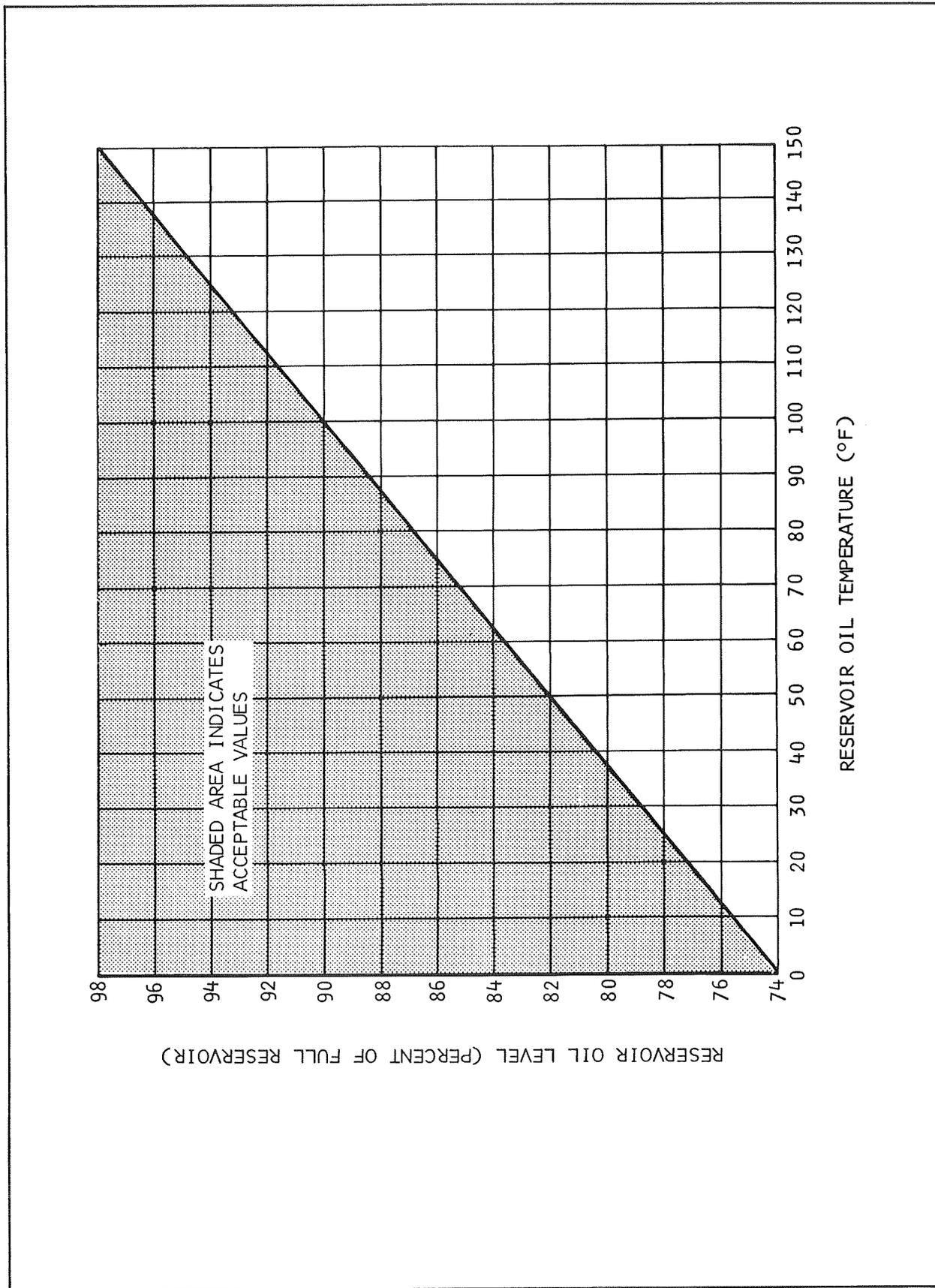


Figure 5-3. Hydraulic Reservoir Level Critical Limits

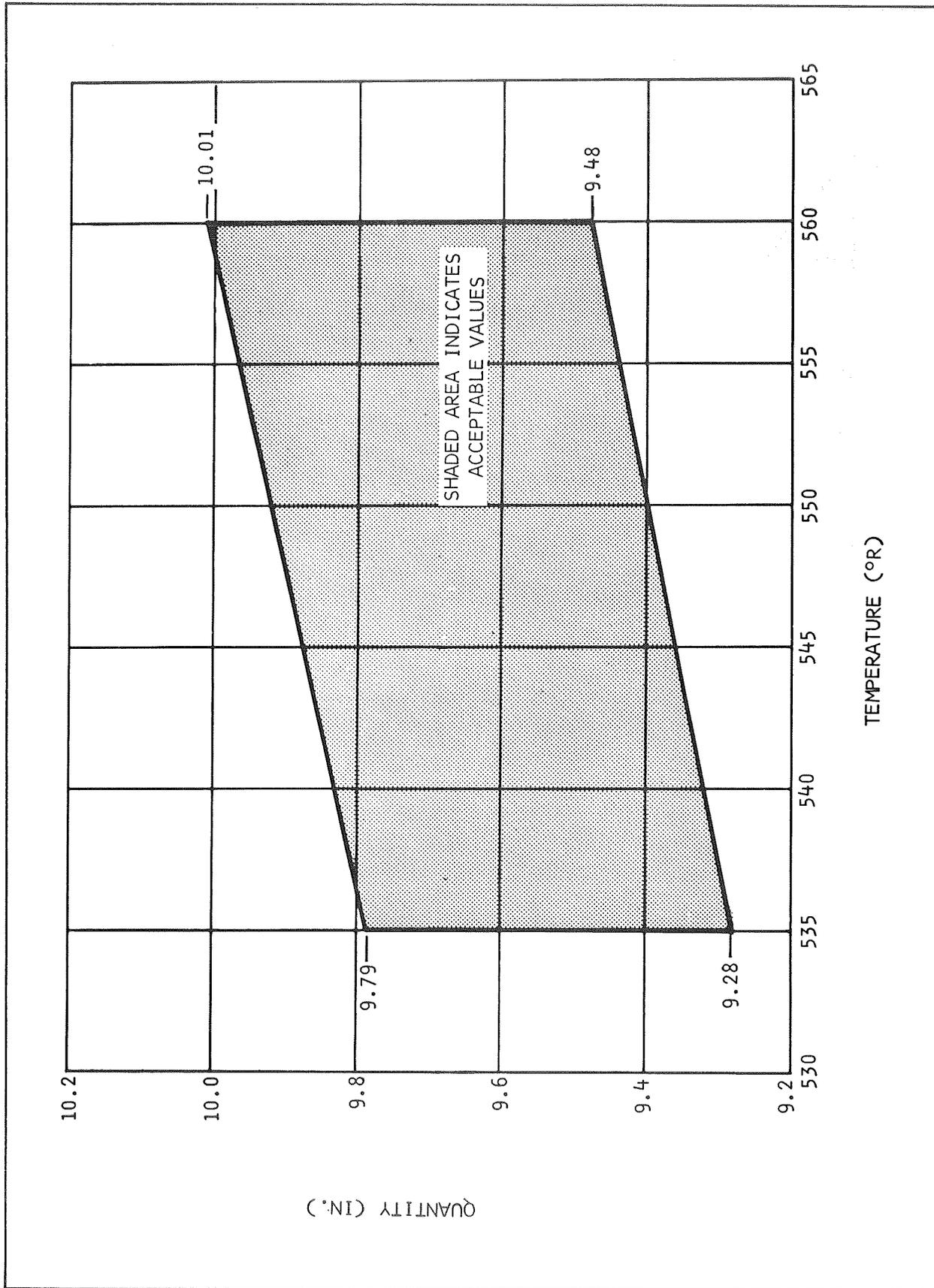


Figure 5-4. APS Oxidizer Critical Limits

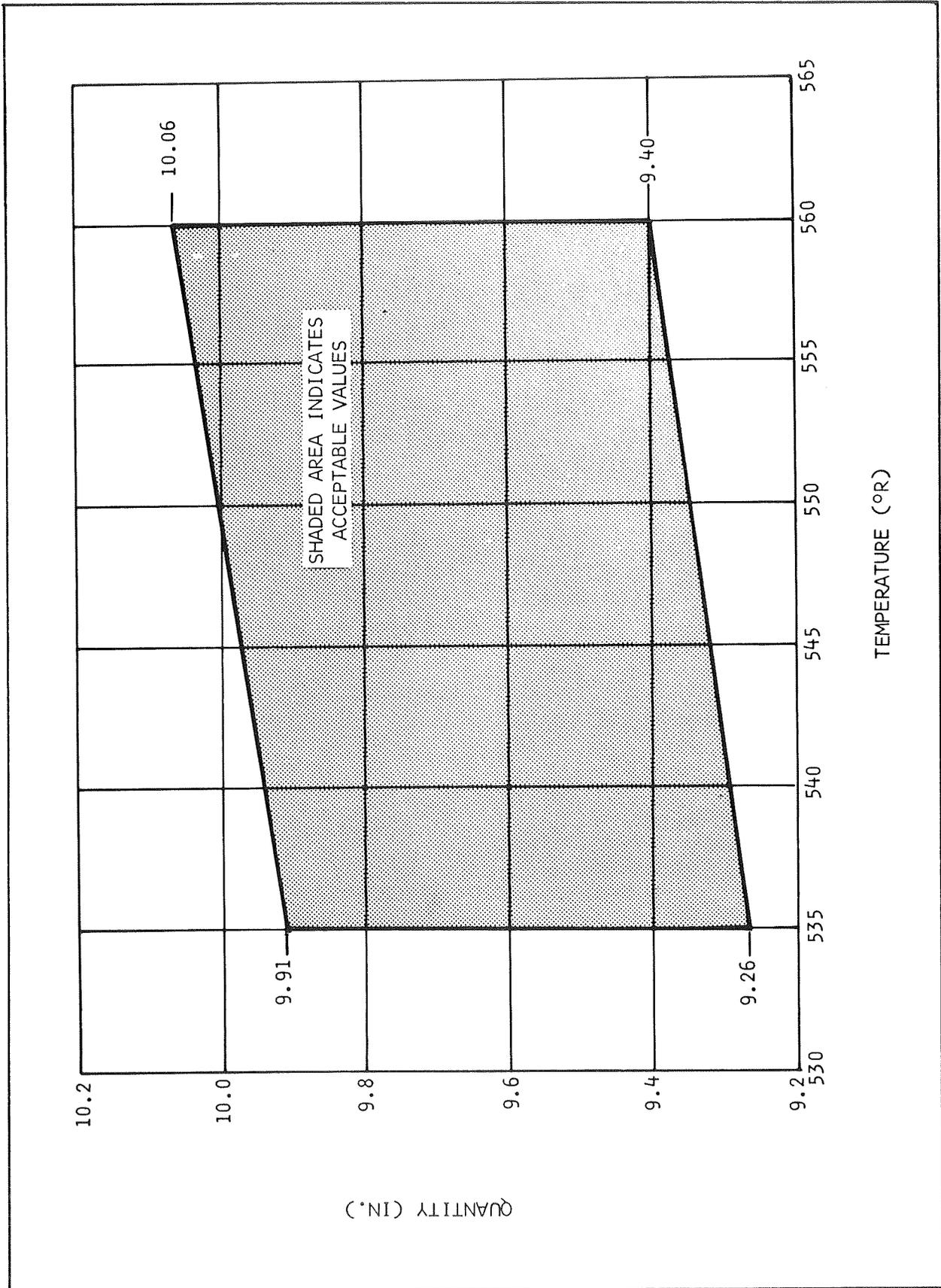


Figure 5-5. APS Fuel Critical Limits

6. TEST MANAGEMENT

6.1 Flight Test Responsibilities

Douglas Aircraft Company, Inc. (DAC) personnel will perform postflight evaluations of the S-IVB-206 stage at the following locations:

- a. Kennedy Space Center (KSC), Cape Kennedy, Florida
- b. Marshall Space Flight Center (MSFC), Huntsville, Alabama
- c. Douglas Aircraft Company, Inc. (DAC/HB), Huntington Beach, California.

At KSC, DAC is represented by the Florida Test Center (DAC/FTC) Test Planning and Evaluation (TP&E) Committee; at Huntington Beach, DAC is represented by the DAC/HB TP&E Committee; and at MSFC, by the DAC/MSFC liaison team.

The DAC/HB and DAC/FTC TP&E Committees consist of personnel assigned from Saturn Engineering sections and branches. Their functions are to:

- a. Coordinate postflight evaluation
- b. Provide information for all contractual documentation
- c. Coordinate test planning for future flights.

The onsite quick-look postflight evaluation, consisting primarily of analog data, is performed by the DAC/FTC TP&E Committee, and the results are transmitted to:

- a. National Aeronautics and Space Administration (NASA), Kennedy Space Center
- b. DAC/HB TP&E Committee
- c. DAC/MSFC liaison team.

The major postflight evaluation is conducted at DAC/HB and consists primarily of analyses from digital data.

All analyses conducted at DAC/FTC and DAC/HB are transmitted to the DAC/MSFC liaison team. This liaison team transmits information between DAC and MSFC, provides the MSFC Flight Evaluation Working Group (FEWG)

with required information, and performs rapid analyses in response to FEWG requests. In addition, the liaison team participates in many of the MSFC postflight evaluations which contribute to, or parallel, DAC postflight evaluation efforts.

The following means of communication (figure 6-1) have been established to expedite transmittal of evaluation information:

- a. TWX communications between DAC/HB, DAC/MSFC, and DAC/FTC locations
- b. Facsimile communications between DAC/HB, DAC/MSFC, and DAC/FTC
- c. Data phone link between DAC/MSFC and DAC/HB.

Transmittal of classified material between DAC facilities by any of the above means is not authorized. A standard format is used for transmission of unclassified data by TWX or facsimile.

To insure rapid and controlled data transmission between locations it is highly desirable that all information be channeled through one coordinator of flight information at each location.

6.2 Preflight Documentation

DAC writes and publishes certain preflight documents for each S-IVB stage flight. Descriptions of the contents, the approximate order of publication, and distribution are given in the following paragraphs.

6.2.1 Saturn S-IVB-206 Instrumentation Program and Components List - 1B43559 (reference 5)

This drawing contains all the telemetry measurements of the S-IVB-206 stage. A partial list of its contents is as follows:

- a. Measurement numbers
- b. Component part numbers
- c. Reference designation numbers
- d. Telemetry channel coding definitions
- e. Measurement list

- f. Measurement matrix by area and function
- g. Measurements, illustrations, and index.

All sections of the Instrumentation Program and Components List are revised as necessary to reflect current instrumentation information. Revisions are controlled by the Saturn Project Office - Test at Huntington Beach, California.

6.2.2 Douglas S-IVB Stage Data Acquisition Requirements Document for Saturn IB Flights - SM-46538

This document describes the detailed data requested by DAC/HB for evaluation of the S-IVB stage of the Saturn IB flights. The requested data will be provided by KSC, Goddard Space Flight Center (GSFC), and MSFC. This document is prepared and maintained at DAC/HB.

6.2.3 S-IVB-206 Stage Flight Test Plan, SM-46979

The contents of the S-IVB-206 Stage Flight Test Plan are described in section 1, Introduction, of this document.

6.3 Postflight Communications and Documentation

Postflight communications and documentation with descriptions of content, approximate order of transmittal or publication, and other responsibilities are briefly described in the following paragraphs.

6.3.1 FTC Postflight Report (24 hr)

Twenty-four hours after launch or as soon as sufficient data are available, the DAC/FTC TP&E Committee will TWX to DAC/HB, DAC/MSFC, and DAC/MSC (Manned Spacecraft Center, Houston) a quick-look evaluation which will include a brief description of system performance, mission objective accomplishments, and any malfunction which may have occurred. This is for internal use only.

6.3.2 FTC Postflight Flash Report (3 days)

The Postflight Flash Report is prepared by the DAC/FTC TP&E Committee and transmitted to KSC. This includes preliminary evaluations of all data available to FTC at that time.

6.3.3 FTC Ground Systems Evaluation Report (8 days)

The DAC/FTC TP&E Committee prepares an evaluation report of the performance of DAC and NASA supplied GSE used in handling propellants for the S-IVB auxiliary propulsion system (APS). This report is transmitted to KSC.

6.3.4 FTC Input to KSC Launch Operations Report (2 wk)

As an input to this report, DAC/FTC will provide information related to the S-IVB stage up to the time of launch.

6.3.5 FTC Preliminary Flight Evaluation Summary (2 wk)

The DAC/FTC TP&E Committee compiles, publishes, and distributes the Preliminary Flight Evaluation Summary for internal use only approximately two weeks after launch. It is the final FTC effort and summarizes test objectives, discusses possible causes of malfunctions, and recommends any corrective action required.

6.3.6 Written Informal Evaluation Inputs to MSFC/FEWG (21 days)

The DAC/MSFC liaison team summarizes all DAC flight evaluations performed during the three-week period subsequent to launch. This summary is forwarded to the FEWG at MSFC and constitutes the DAC input to the MSFC Saturn Vehicle Flight Evaluation Report.

6.3.7 S-IVB-206 Stage Flight Evaluation Report (60 days)

Sixty days after launch the DAC/HB TP&E Committee will write, publish, and distribute DAC Report No. SM-46991, S-IVB-206 Stage Flight Evaluation Report. The data for evaluation are required at DAC/HB by 15 days after launch, thereby allowing 45 days for preparation of the report. Tentative evaluation meetings and documentation schedules are shown in tables 6-1 and 6-2. A probable evaluation report outline is delineated in table 6-3.

TABLE 6-1
TENTATIVE AS-206 FLIGHT EVALUATION MEETING SCHEDULE

DAYS AFTER LAUNCH	EVENT SCHEDULED	MEETING LOCATION
1	Flight Review Meeting	MSFC
5	First "How-Goes-It" Meeting	DAC/HB
6	First General Evaluation Meeting	MSFC
13	Second "How-Goes-It" Meeting	DAC/HB
14	Second General Evaluation Meeting	MSFC
15	Third "How-Goes-It" Meeting	DAC/HB
16	Third General Evaluation Meeting	MSFC
20	Fourth "How-Goes-It" Meeting	DAC/HB
21	Summary Meeting	MSFC

TABLE 6-2
EVALUATION AND DOCUMENTATION SCHEDULE FOR S-IVB-206
STAGE FLIGHT EVALUATION REPORT

DAYS AFTER LAUNCH	EVENT
0	Launch
1	Support FEWG Flight Review Meeting
6	Support FEWG First General Evaluation Meeting
14	Support FEWG Second General Evaluation Meeting
15	All Final Data Due at A3
16	Support FEWG Third General Evaluation Meeting
21	Written Informal Evaluation Inputs to MSFC/FEWG Report Due; Support FEWG Summary Meeting
26	*First Inputs Due from Design Sections
40	*All Final Evaluation Inputs Due for 60-Day Report
45	Management Review Copy to Reproduction
47	Management Review Copy Distributed
50	Management Review Comments Due
53	Final Report to Reproduction
60	Final 60-Day Evaluation Report Distributed

*A detailed outline will be published immediately after launch, indicating when inputs are due during the 26-to-40 day period.

TABLE 6-3 (Sheet 1 of 5)
S-IVB-206 STAGE FLIGHT EVALUATION REPORT OUTLINE

<u>SECTION</u>	<u>ENGINEERING SECTION</u>
1. INTRODUCTION	S-IVB Project
2. SUMMARY	S-IVB Project*
3. TEST CONFIGURATION	DAC/FTC TP&E Committee† and Propulsion
3.1 Stage Configuration	
3.2 Stage Modifications	
3.3 Ground Support Equipment Modifications	
4. SEQUENCE OF EVENTS	Electronics and FD&C
5. COUNTDOWN OPERATIONS	
5.1 Propulsion Systems Checkouts	Propulsion
5.2 Launch Vehicle Tests	Propulsion
5.3 Countdown Demonstration Test	Propulsion
5.4 Launch Countdown	Propulsion
5.5 Environmental Control Systems	Structural/Mechanical
5.6 Terminal Count	Propulsion and Electronics
5.7 Holds	Propulsion
5.8 Launch Environment	DAC/FTC TP&E Committee
6. CPIF	FD&C and S-IVB Project
7. TRAJECTORY	FD&C
7.1 Comparison Between Actual and Preflight Predicted Trajectories	
7.2 Trajectory Simulation Analysis	

* Each Design Technology will summarize its individual areas. The S-IVB TP&E Section will insure compatibility between the various analyses. A separate anomaly summary will be developed by the TP&E Committee.

† Includes serial numbers of significant stage end items, orifice sizes, nominal pressure switch settings, and nominal regulator settings. Significant modifications to the stage since acceptance firing are listed, if any.

TABLE 6-3 (Sheet 2 of 5)
S-IVB-206 STAGE FLIGHT EVALUATION REPORT OUTLINE

<u>SECTION</u>	<u>ENGINEERING SECTION</u>
8. MASS CHARACTERISTICS	Weight Control
9. ENGINE SYSTEMS	
9.1 Engine Chillover and Conditioning . . .	Propulsion
9.2 Engine Performance	Propulsion
9.3 Sequence of Events	Propulsion
9.4 Component Operation	Propulsion
9.5 Flight Simulation Analysis	FD&C
10. SOLID ROCKET PERFORMANCE	Propulsion
10.1 Ullage Rockets	
10.2 Retrorockets	
11. OXIDIZER SYSTEM	Propulsion
11.1 Pressurization Control and Internal Environment	
11.2 Cold Helium Supply	
11.3 Heat Exchanger	
11.4 LOX Chillover	
11.5 Engine LOX Supply	
12. FUEL SYSTEM	Propulsion
12.1 Pressurization Control and Internal Environment	
12.2 LH2 Chillover	
12.3 LH2 Supply	
12.4 LH2 Boiloff	
13. AUXILIARY PROPULSION SYSTEM	Propulsion
13.1 Operation	
13.1.1 Oxidizer System	
13.1.2 Fuel System	
13.1.3 Helium System	
13.2 Module No. 1 Performance	
13.3 Module No. 2 Performance	

TABLE 6-3 (Sheet 3 of 5)
S-IVB-206 STAGE FLIGHT EVALUATION REPORT OUTLINE

<u>SECTION</u>	<u>ENGINEERING SECTION</u>
14. PNEUMATIC CONTROL AND PURGE	Propulsion
14.1 Ambient Helium Supply	
14.2 Pneumatic Control	
14.3 Stage Helium Purge System	
15. PROPELLANT UTILIZATION	PU Analysis Panel
15.1 Propellant Mass History	
15.2 System Performance	
15.3 Subsystem Performance	
16. S-IB/S-IVB STAGE SEPARATION	FD&C
16.1 Stage Separation and Clearance Analysis	
16.2 Control System Response to Separation Transient	
17. DATA ACQUISITION SYSTEM PERFORMANCE	Electronics
17.1 Instrumentation System Performance	
17.2 Telemetry System Performance	
18. ELECTRICAL SYSTEM PERFORMANCE	Electronics
18.1 Control System	
18.2 Electrical Power System	
19. RANGE SAFETY SYSTEM PERFORMANCE	Electronics
19.1 Controllers	
19.2 Firing Unit Monitors	
19.3 CDR Signal Strength	
20. FLIGHT CONTROL	FD&C
20.1 General	
20.2 Critical Parameters During Transient Periods	
20.3 Sloshing	
20.4 Body Bending	
20.5 Flight Control System	
20.6 APS System Simulation	

TABLE 6-3 (Sheet 4 of 5)
S-IVB-206 STAGE FLIGHT EVALUATION REPORT OUTLINE

<u>SECTION</u>	<u>ENGINEERING SECTION</u>
21. HYDRAULIC SYSTEM PERFORMANCE	Structural/Mechanical
21.1 Hydraulic Systems Operation	
21.2 Servo Systems Operation	
22. STAGE STRUCTURE AND ENVIRONMENT	
22.1 Explosive Ordnance Equipment	Structural/Mechanical
22.2 Flight Loads (Strain Analysis) Strength	
23. FORWARD SKIRT THERMOCONDITIONING	Structural/Mechanical
24. AERO/THERMODYNAMIC ENVIRONMENT	Aero/Thermodynamics
24.1 Aerodynamic Environments	
24.2 Thermodynamic Environments	
25. ORBITAL FLIGHT ANALYSES	
25.1 Summary	S-IVB Project
25.2 Sequence of Events	Electronics, FD&C, Propulsion
25.3 Vent Systems	Propulsion
25.4 Auxiliary Propulsion System	Propulsion
25.5 Vehicle Motion and Forces	FD&C
25.6 Flight Control	FD&C
25.7 Thermodynamic Environment	Aero/Thermodynamics
25.8 Data Acquisition and Electrical Systems	Electronics
25.9 Hydraulic System	Structural/Mechanical
25.10 Stage Pneumatic Control System	Propulsion
25.11 Forward Skirt Thermoconditioning	Structural/Mechanical
25.12 S-IVB/CSM Separation	FD&C

TABLE 6-3 (Sheet 5 of 5)
S-IVB-206 STAGE FLIGHT EVALUATION REPORT OUTLINE

<u>APPENDIX</u>	<u>ENGINEERING SECTION</u>
1. Mass Characteristics (WS11)	Weight Control
2. Flight Test Reconstruction (PA49)	Propulsion
3. Flight Test Data (AA89)	Propulsion
4. Flowmeter Reconstruction (G105)	Propulsion
5. Flight Test Data (F823)	Propulsion
6. Observed Trajectory (AA83)	FD&C
7. Flight Simulated Data (AC77)	FD&C
8. Meteorological Data	FD&C
9. Glossary and Abbreviations	S-IVB Project

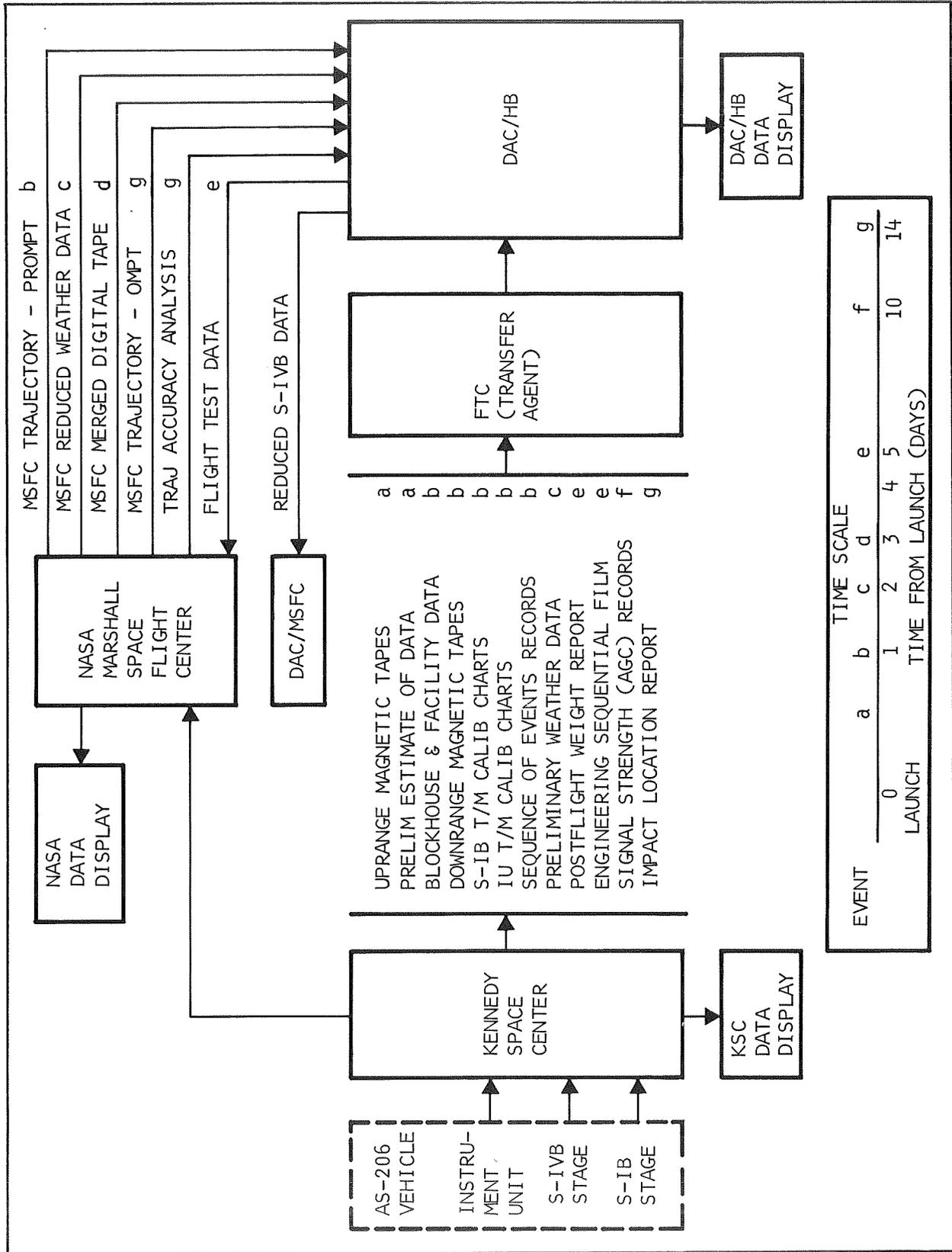


Figure 6-1. Data Flow Chart

7. CPIF CONTRACT TECHNICAL PERFORMANCE CRITERIA

7.1 General

Douglas Aircraft Company, Inc. (DAC) will be awarded a bonus if the S-IVB-206 stage successfully accomplishes the assigned flight mission. Conversely, DAC will be assessed a penalty if the S-IVB-206 stage fails to accomplish the assigned flight mission because of inadequate stage performance.

7.2 Flight Mission Accomplishment

A mission is considered successful if the S-IVB-206 stage delivers to the payload acceptably valued end conditions of flight (ECF) or, if having received from the S-IB-206 stage and IU inadequate preconditions of flight (PCF), the S-IVB stage performance is such that the ECF would have been acceptably valued had the PCF been adequate.

As of the publication date of this document, DAC has not been provided sufficient mission definition to establish the PCF and ECF; and therefore, it is intended that they will be included in a subsequent revision to this document.

The Contract End-Item Detail Specification Performance/Design Requirements S-IVB Stage, for use with Saturn Vehicle SA-206 is CEI No. 208006A (reference 10).

7.3 Payload Capability

The capability of the S-IVB-206 stage to meet a specification payload will be established by engineering analysis, in accordance with the methodology set forth in DAC Report No. SM-47263, Specification for the Calculation of Payload Capability Under the CPIF Exhibit to NAS7-101, dated 12 January 1966 (reference 11). The provisions of Exhibit J to Supplemental

Agreement 800 will apply in the event of any conflict with the provisions of SM-47263. Within sixty (60) days after launch a Certificate of Payload Capability will be delivered to the Contracting Officer stating specification payload capability and predicted payload capability for the S-IVB-206 stage.

7.4 Telemetry Performance

The information in the following paragraphs defines the total number of S-IVB-206 measurements that will be evaluated under the CPIF (cost plus incentive fee) contract.

- a. The measurements to be evaluated are those listed in DAC Drawing No. 1B43559, Instrumentation Program and Components List Saturn S-IVB-206. Of these 231 measurements, only those that are wholly located on the S-IVB-206 stage and which are operative at the start of the automatic launch sequence during terminal launch countdown are to be evaluated under the CPIF contract. Certain measurements that appear on this list are not active during flight. These measurements are listed below along with the reasons why they will not be included among the CPIF measurements:

<u>Measurement Number</u>	<u>Measurement Title</u>	<u>Reason</u>
K0141-411	Event - R/S 1 Pulse Sensor	These measurements are for checkout only and are not transmitted during flight by the S-IVB-206 stage T/M system.
K0142-411	Event - R/S 2 Pulse Sensor	
K0143-404	Event - U/R 1 Ignition Pulse Sensor 1	
K0144-404	Event - U/R 1 Ignition Pulse Sensor 2	
K0145-404	Event - U/R 2 Ignition Pulse Sensor 1	

K0146-404	Event - U/R 2 Ignition Pulse Sensor 2
K0147-404	Event - U/R 3 Ignition Pulse Sensor 1
K0148-404	Event - U/R 3 Ignition Pulse Sensor 2
K0149-404	Event - U/R Jettison 1 Pulse Sensor
K0150-404	Event - U/R Jettison 2 Pulse Sensor
K0151-411	Event - PU Oven On Indication
K0152-404	Event - Rate Gyro Wheel Speed OK Ind
K0168-404	Event - Switch Selector Register Test
K0169-404	Event - EBW Pulse Sensor OFF Ind

These measurements are for checkout only and are not transmitted during flight by the S-IVB-206 stage T/M system.

- b. As stated above, 14 of the 231 measurements appearing in the IP&CL will not be evaluated for incentive purposes. Therefore, the maximum number of measurements that may be evaluated is 217 (see e. below).
- c. The expected duration of the Telemetry Performance Evaluation Period (TPEP) Phase I, is from AS-206 liftoff until 10 sec after the S-IVB engine cutoff signal.
- d. The duration of TPEP Phase II, is the duration of orbital attitude control or liftoff plus 4.5 hours, whichever occurs first. (The duration of orbital attitude control is yet to be defined.)
- e. All measurements which are inoperative at the start of the automatic launch sequence during the terminal launch countdown will be subtracted from the total number of measurements stated

in paragraph b. above (217). The resulting number of measurements will be used to determine telemetry performance for incentive accomplishment.

f. To insure the required transmission of data from the S-IVB telemetry system, the following commands must be received from the IU as scheduled in the sequence of events:

- (1) T/M Calibration Relays ON
- (2) T/M Calibration Relays OFF
- (3) PCM System Group ON
- * (4) PCM System Group OFF
- (5) PCM RF Assembly Group ON
- * (6) PCM RF Assembly Group OFF

* This command may not be used during flight, but the capability must exist.

1. SEQUENCE OF EVENTS

The AS-206 flight sequence of events presented in this appendix is based upon MSFC's sequence requirements as indicated in the Interface Control Document 40M33606, Definition of Saturn SA-206 Flight Sequence Program and Interface Revision Notices R-1, R-2, and R-3 thereto (reference 12). This sequence of events is subject to change and is accurate only as of this date of publication. Table AP-1 presents the planned flight sequence of events. Table AP-2 defines the symbols used with the sequence of events.

The flight times presented in the sequence of events do not reflect the changes in trajectory due to final propulsion predictions presented in appendix 5.

TABLE AP 1-1 (Sheet 1 of 6)
 PREDICTED AS-206 FLIGHT SEQUENCE OF EVENTS

SEQ	EVENT	FLIGHT TIME (Sec)	TIME FROM BASE (Sec)	TIME FROM S-IVB ENGINE START (Sec)	SSS	REMARKS
1.	Liftoff - Start of Time Base #1 (T ₁)	0.0	(0.0) ₁	-143.9		
2.	Roll Maneuver Start	10.0	N/A	-133.9		
3.	Pitch Maneuver Start	10.0	N/A	-133.9		
4.	Separation Expulsion Panel #1	10.2	(10.2) ₁	-133.7	IU	
5.	Separation Expulsion Panel #1 Reset	10.4	(10.4) ₁	-133.5	IU	
6.	Roll Maneuver Stop	38.0	N/A	-105.9		
7.	Maximum Dynamic Pressure	75.2	N/A	-68.9		
8.	Regular Calibration Relays On	127.7	(127.7) ₁	-16.2	S-IVB	
9.	Pitch Maneuver Stop	131.2	N/A	-12.7		
10.	Regular Calibration Relays Off	132.1	(132.1) ₁	-11.8	S-IVB	
11.	Enable Propellant Level Sensors	133.7	(133.7) ₁	-10.2	S-IVB	
12.	S-IB Propellant Level Sensor Actuation - Start of Time Base #2 (T ₂)	135.7	(0.0) ₂	-8.2	S-IB	
13.	Inboard Engines Cutoff	138.7	(3.0) ₂	-5.2	S-IB	
14.	Charge Ullage Ignition On	138.9	(3.2) ₂	-5.0	S-IVB	
15.	Q-Ball Power Off	139.5	(3.8) ₂	-4.4	IU	
16.	Prevalves Closed Off	140.0	(4.3) ₂	-3.9	S-IVB	
17.	LOX Depletion Cutoff Enable	140.2	(4.5) ₂	-3.7	S-IB	
18.	Fuel Depletion Cutoff Enable	141.2	(5.5) ₂	-2.7	S-IB	

TABLE AP 1-1 (Sheet 2 of 6)
 PREDICTED AS-206 FLIGHT SEQUENCE OF EVENTS

SEQ	EVENT	FLIGHT TIME (Sec)	TIME FROM BASE (Sec)	TIME FROM S-IVB ENGINE START (Sec)	SSS	REMARKS
19.	S-IB Outboard Engines Cutoff - Start of Time Base #3 (T ₃)	141.7	(0.0) ₃	-2.2	S-IB	
20.	Separation Expulsion Panel #2	141.9	(0.2) ₃	-2.0	IU	
21.	Separation Expulsion Panel #2 Reset	142.1	(0.4) ₃	-1.8	IU	
22.	Fire Ullage Ignition On	142.3	(0.6) ₃	-1.6	S-IVB	
23.	S-IB/S-IVB Separation On	142.5	(0.8) ₃	-1.4	S-IB	This signal is given when H-1 engine thrust decays to approximately 10 percent.
24.	Flight Control Computer S-IVB Burn Mode On	142.7	(1.0) ₃	-1.2	IU	This command enables the APS to control roll and enables J-2 engine gimbaling
25.	Engine Cutoff Off	142.9	(1.2) ₃	-1.0	S-IVB	The engine ready signal must be received by the engine after this time or the engine will not start.
26.	Engine Ready Bypass On	143.1	(1.4) ₃	-0.8	S-IVB	
27.	Fuel Chilldown Pump Off	143.3	(1.6) ₃	-0.6	S-IVB	
28.	LOX Chilldown Pump Off	143.5	(1.8) ₃	-0.4	S-IVB	
29.	Chilldown Shutoff Valves Closed On	143.7	(2.0) ₃	-0.2	S-IVB	
30.	Engine Start On	143.9	(2.2) ₃	0.0	S-IVB	
31.	EDS Arming of S-IVB Engine Pressure Switches "A"	144.1	(2.4) ₃	0.2	IU	

TABLE AP 1-1 (Sheet 3 of 6)
 PREDICTED AS-206 FLIGHT SEQUENCE OF EVENTS

SEQ	EVENT	FLIGHT TIME (Sec)	TIME FROM BASE (Sec)	TIME FROM S-IVB ENGINE START (Sec)	SSS	REMARKS
32.	EDS Arming of S-IVB Engine Pressure Switches "B"	144.3	(2.6) ₃	0.4	IU	
33.	Engine Start Off	144.5	(2.8) ₃	0.6	S-IVB	
34.	LOX Tank Flight Pressure System On	144.7	(3.0) ₃	0.8	S-IVB	
35.	Fuel Injection Temperature OK Bypass	144.9	(3.2) ₃	1.0	S-IVB	
36.	Engine Burning #1 Relay On	146.7	(5.0) ₃	2.8	S-IVB	
37.	PU Activate On	149.9	(8.2) ₃	6.0	S-IVB	
38.	Charge Ullage Jettison On	151.4	(9.7) ₃	7.5	S-IVB	
39.	Fire Ullage Jettison On	154.5	(12.8) ₃	10.6	S-IVB	
40.	Ullage Charging Reset	160.5	(18.8) ₃	16.6	S-IVB	
41.	Ullage Firing Reset	160.7	(19.0) ₃	16.8	S-IVB	
42.	Flight Control Computer Switch Point #4	284.9	(143.2) ₃	141.0	IU	
43.	Regular Calibration Relays On	355.0	(213.3) ₃	211.1	S-IVB	
44.	Regular Calibration Relays Off	359.5	(217.8) ₃	215.6	S-IVB	
45.	PU Valve Cutback	423.9	N/A	280.0		
46.	Engine Burning #1 Relay Off	444.1	(302.4) ₃	300.2	S-IVB	This signal causes both LH2 pressurizing valves to open and remain open throughout the remainder of the flight.
47.	Point Level Sensor Arming	586.9	(445.2) ₃	433.0	S-IVB	Normal engine cutoff occurs at a predicted

TABLE AP 1-1 (Sheet 4 of 6)
 PREDICTED AS-206 FLIGHT SEQUENCE OF EVENTS

SEQ	EVENT	FLIGHT TIME (Sec)	TIME FROM BASE (Sec)	TIME FROM S-IVB ENGINE START (Sec)	SSS	REMARKS
47.	Cont.	598.9	(0.0) ₄	455.0	S-IVB	velocity cutoff. This signal provides a back-up for cutoff.
48.	S-IVB Engine Cutoff - Start of Time Base #4 (T ₄)	599.1	(0.2) ₄	455.2	S-IVB	
49.	LH2 Tank Vent Open On	599.3	(0.4) ₄	455.4	S-IVB	
50.	LOX Tank Vent Open On	599.5	(0.6) ₄	455.6	S-IVB	
51.	Prevalves Closed On	599.7	(0.8) ₄	455.8	S-IVB	
52.	LOX Tank Flight Pressure System Off	599.9	(1.0) ₄	456.0	S-IVB	This signal closes the LOX pressurization shut-off valves and disables the control functions of pressure switch.
53.	Coast Period On	600.5	(1.6) ₄	456.6	S-IVB	
54.	LOX Chilldown Pump Purge Control Valve Open Off	600.7	(1.8) ₄	456.8	S-IVB	
55.	Point Level Sensor Disarming	601.1	(2.2) ₄	457.2	S-IVB	
56.	PU Activate Off	601.5	(2.6) ₄	457.6	S-IVB	
57.	PU Inverter and DC Power Off	603.9	(5.0) ₄	460.0	IU	This signal enables the APS to control pitch and yaw.
58.	Flight Control Computer S-IVB Burn Mode Off	604.1	(5.2) ₄	460.2	S-IVB	
59.	Auxiliary Hydraulic Pump Off					

TABLE AP 1-1 (Sheet 5 of 6)
 PREDICTED AS-206 FLIGHT SEQUENCE OF EVENTS

SEQ	EVENT	FLIGHT TIME (Sec)	TIME FROM BASE (Sec)	TIME FROM S-IVB ENGINE START (Sec)	SSS	REMARKS
60.	Regular Calibrate Relays On	630.4	(31.5) ₄	486.5	S-IVB	
61.	Regular Calibrate Relays Off	635.0	(36.1) ₄	491.1	S-IVB	
62.	LOX Tank Vent Open Off	TBD	TBD	TBD	S-IVB	
63.	LOX Tank Vent Closed On	TBD	TBD	TBD	S-IVB	
64.	LOX Tank Vent Closed Off	TBD	TBD	TBD	S-IVB	
65.	Chilldown Shutoff Valves Closed Off	659.2	(60.3) ₄	515.3	S-IVB	
66.	Prevalves Closed Off	659.4	(60.5) ₄	515.5	S-IVB	
67.	LH2 Tank Vent Open Off	TBD	TBD	TBD	S-IVB	
68.	LH2 Tank Vent Closed On	TBD	TBD	TBD	S-IVB	
69.	LH2 Tank Vent Closed Off	TBD	TBD	TBD	S-IVB	
70.	SLA Panel Deployment A*	2,398.9	(1,800.0) ₄	2,255.0	IU	
71.	SLA Panel Deployment B	2,399.1	(1,800.2) ₄	2,255.2	IU	
72.	Separation Expulsion Panel #3	3,350.9	(2,752.0) ₄	3,207.0	IU	
73.	Separation Expulsion Panel #3 Reset	3,351.1	(2,752.2) ₄	3,207.2	IU	
	<u>In Range - Carnarvon</u>					
74.	Regular Calibration Relays On	TBD	TBD	TBD	S-IVB	
75.	Regular Calibration Relays Off	TBD	TBD	TBD	S-IVB	

* This function will also be programmed for initiation by ground command

TABLE AP 1-1 (Sheet 6 of 6)
 PREDICTED AS-206 FLIGHT SEQUENCE OF EVENTS

SEQ	EVENT	FLIGHT TIME (Sec)	TIME FROM BASE (Sec)	TIME FROM S-IVB ENGINE START (Sec)	SSS	REMARKS
	<u>In Range - Guaymas</u>					
76.	Regular Calibration Relays On	TBD	TBD	TBD	S-IVB	
77.	Regular Calibration Relays Off	TBD	TBD	TBD	S-IVB	
	<u>BEGIN SECOND REVOLUTION</u>					
	<u>In Range - Cape Kennedy</u>					
78.	Regular Calibration Relays On	TBD	TBD	TBD	S-IVB	
79.	Regular Calibration Relays Off	TBD	TBD	TBD	S-IVB	
	<u>In Range - Carnarvon</u>					
80.	Regular Calibration Relays On	TBD	TBD	TBD	S-IVB	
81.	Regular Calibration Relays Off	TBD	TBD	TBD	S-IVB	
	<u>In Range - Guaymas</u>					
82.	Regular Calibration Relays On	TBD	TBD	TBD	S-IVB	
83.	Regular Calibration Relays Off	TBD	TBD	TBD	S-IVB	
	<u>In Range - Cape Kennedy</u>					
84.	Regular Calibration Relays On	TBD	TBD	TBD	S-IVB	
85.	Regular Calibration Relays Off	TBD	TBD	TBD	S-IVB	

TABLE AP 1-2
SYMBOL DEFINITIONS

SYMBOL	DEFINITION
APS	Auxiliary Propulsion System
CSM	Command-Service Module
EDS	Emergency Detection System
IU	Instrument Unit
LM	Lunar Module
LET	Launch Escape Tower
LV/SC	Launch Vehicle/Spacecraft
N/A	Not Applicable
PU	Propellant Utilization (System)
SLA	Spacecraft LM Adapter
SSS	Stage Switch Selector
T ₁	Time Base Initiated by Vehicle Liftoff
T ₂	Time Base Initiated by Actuation of any S-IB Propellant Level Sensor
T ₃	Time Base Initiated by S-IB Outboard Engine Cutoff Command
T ₄	Time Base Initiated by S-IVB Engine Cutoff Command

2. MASS CHARACTERISTICS DATA (WS11)

This appendix presents the S-IVB-206 stage mass characteristics as computed for the WS11 computer program.

Table AP 2-1 is a mass breakdown summary consisting of an itemized listing of major components (including all propellants, gases, etc.) giving mass, center of gravity, and moments of inertia including a summation for the indicated time. In addition, a jettisoned item summary is presented at the appropriate times. Table AP 2-2 is a mass characteristics summary which includes a time listing of the S-IVB-206 stage mass characteristics. Figures AP 2-1 and AP 2-2 present graphs of S-IVB-206 stage mass characteristics. Supplementary information is contained in table AP 2-3 (definitions of terms and abbreviations used in the printouts), and figure AP 2-3, S-IVB-206 stage station numbers.

All mass characteristics parameters are time referenced to AS-206 vehicle liftoff and progress chronologically from liftoff to separation. Data are also presented at a predicted S-IVB engine cutoff time of 586.4 sec.

There will normally be some optional conversions of individual parameter totals. These conversions will appear below the total line in the appropriate columns under abbreviations indicating the unit system to which they have been converted.

The sources of the mass characteristics data presented in the WS11 computer program are presented below. It should be noted that the data presented in this appendix were based on the final propulsion predictions as presented in appendix 5 of this test plan; therefore, some flight times are not in agreement with trajectory information and with appendix 1, which were based on preliminary S-IVB engine performance data.

- a. The S-IVB-206 stage dry mass is based on the stage weight as measured at DAC/STC on 7 December 1966.
- b. The S-IVB payload (IU, adapter, service module and propellants, command module, launch escape system) data were derived from MSFC memorandum R-P&VE-VAW-66-62: Saturn IB, AS-206 Mass Characteristics, dated 13 July 1966 (reference 13).

- c. Propellant mass flows are based on those found in appendix 5 of this document
- d. S-IVB-206 propellant loading as presented in appendix 6 of this document.

TABLE AP 2-1 (Sheet 1 of 9)
 PREDICTED S-IVB-206 MASS BREAKDOWN SUMMARY

AS-206 LIFTOFF		TIME 0.0				ITEMS REMAINING		
SFO	DESCRIPTION	MASS (POUNDS)	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
			H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
1.	AFT FRAME	30.95	200.70	0.0	0.0	.52064367 06	.36812188 06	.36812188 06
2.	DETONATION PKG	4.74	201.00	0.0	0.0	.80105998 05	.56636723 05	.56636723 05
3.	FROST	100.00	420.40	0.0	0.0	.16926009 07	.14472090 07	.14472090 07
7.	ULLAGE RKT GRN	176.00	225.80	0.0	0.0	.35433678 07	.17861443 07	.17861443 07
8.	ULLAGE RKT CSE	214.46	222.00	0.4	-0.7	.39328909 07	.19653613 07	.19653613 07
23.	NOSE CONE	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
25.	SLA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	IFM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMENT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30452250 08
29.	EXPERIMENT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.40248599 06	.10062150 06
30.	S4R206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89879915 09
31.	LX ULLAGE GAS	40.00	318.26	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LX IN TANK	192906.00	241.78	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LX RFLD VALVE	0.00	71.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
37.	LH2 ULLAGE GAS	189.00	619.49	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LH2 IN TANK	37588.00	436.51	0.0	0.0	.00000000 00	.12600826 09	.12600826 09
39.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LH2 IN ENGINE	10.00	71.00	0.0	0.0	.12682576 05	.55790439 04	.55790439 04
41.	LH2 RELO VALVE	0.00	71.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
42.	CHLD HE QUAD 1	86.00	521.30	86.3	-75.6	.00000000 00	.30395840 05	.30395840 05
43.	CHLD HE QUAD 2	172.00	494.30	113.8	20.0	.00000000 00	.15812001 06	.15812001 06
44.	APS PRDP FP 1	64.00	248.00	0.0	-140.0	.00000000 00	.92160000 04	.92160000 04
45.	APS PRDP FP 3	64.00	248.00	0.0	140.0	.00000000 00	.92160000 04	.92160000 04
46.	APS HELIUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.2	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HE ENG PNFU	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HE VEH PNFU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	5.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	FNV CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		296519.20	352.79	0.9	-0.5	.48933764 09	.12733218 11	.12730052 11
						.SLF .10561867 06	.SLF .27483386 07	.SLF .27476554 07

S-IB/S-IVB SEPARATION		TIME 142.5				ITEMS JETTISONED		
SFO	DESCRIPTION	MASS (POUNDS)	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
			H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
1.	AFT FRAME	30.95	200.70	0.0	0.0	.52064367 06	.36812188 06	.36812188 06
2.	DETONATION PKG	4.74	201.00	0.0	0.0	.80105998 05	.56636723 05	.56636723 05
3.	FROST	-0.00	420.40	0.0	0.0	-.00000000 00	-.00000000 00	-.00000000 00
TOTAL JETTISONED		35.69	200.74	-0.0	-0.0	.60074966 06	.42475902 06	.42475902 06
						.SLF .12966585 03	.SLF .91680017 02	.SLF .91680017 02

S-IB/S-IVB SEPARATION		TIME 142.5				ITEMS REMAINING		
SFO	DESCRIPTION	MASS (POUNDS)	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
			H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
7.	ULLAGE RKT GRN	171.37	225.80	0.0	0.0	.34501195 07	.17391396 07	.17391396 07
8.	ULLAGE RKT CSE	214.46	222.00	0.4	-0.7	.39328909 07	.19653613 07	.19653613 07
23.	NOSE CONE	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
25.	SLA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	IFM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMENT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30452250 08
29.	EXPERIMENT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.40248599 06	.10062150 06
30.	S4R206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89879915 09
31.	LX ULLAGE GAS	40.00	318.26	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LX IN TANK	192906.00	241.78	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LX RFLD VALVE	0.00	71.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
37.	LH2 ULLAGE GAS	189.00	619.49	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LH2 IN TANK	37588.00	436.51	0.0	0.0	.00000000 00	.12600826 09	.12600826 09
39.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LH2 IN ENGINE	10.00	71.00	0.0	0.0	.12682576 05	.55790439 04	.55790439 04
41.	LH2 RELO VALVE	0.00	71.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
42.	CHLD HE QUAD 1	86.00	521.30	86.3	-75.6	.00000000 00	.30395840 05	.30395840 05
43.	CHLD HE QUAD 2	172.00	494.30	113.8	20.0	.00000000 00	.15812001 06	.15812001 06
44.	APS PRDP FP 1	64.00	248.00	0.0	-140.0	.00000000 00	.92160000 04	.92160000 04
45.	APS PRDP FP 3	64.00	248.00	0.0	140.0	.00000000 00	.92160000 04	.92160000 04
46.	APS HELIUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.2	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HE ENG PNFU	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HE VEH PNFU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	5.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	FNV CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		296378.88	352.79	0.9	-0.5	.48695090 09	.12729942 11	.12726777 11
						.SLF .10510352 06	.SLF .27476316 07	.SLF .27469485 07

TABLE AP 2-1 (Sheet 2 of 9)
 PREDICTED S-IVB-206 MASS BREAKDOWN SUMMARY

S-IVB ESC		TIME 143.9				ITEMS REMAINING		
SFO	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
7.	ULLAGE RKT GRN	106.53	225.80	0.0	0.0	.21446489 07	.16810767 07	.16810767 07
8.	ULLAGE RKT CSE	214.46	222.00	0.4	-0.7	.39328909 07	.19653613 07	.19653613 07
23.	NOSF CONF	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
25.	SLA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	LEM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMENT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMENT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.40248599 06	.10062150 06
30.	S48206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89879915 09
31.	LOX ULLAGE GAS	40.00	318.26	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LOX IN TANK	192906.00	241.78	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LOX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LOX REFLO VALVE	0.00	71.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
37.	LH2 ULLAGE GAS	189.00	619.49	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LH2 IN TANK	37588.00	436.51	0.0	0.0	.00000000 00	.12660826 09	.12660826 09
39.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LH2 IN ENGINE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
41.	LH2 REFLO VALVE	0.00	71.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
42.	COLD HE QUAD 1	86.00	521.30	86.3	-75.6	.00000000 00	.30395840 05	.30395840 05
43.	COLD HE QUAD 2	172.00	494.30	113.8	20.0	.00000000 00	.15812001 06	.15812001 06
44.	APS PRNP FP 1	64.00	248.00	0.0	-140.0	.00000000 00	.92160000 04	.92160000 04
45.	APS PRNP FP 3	64.00	248.00	0.0	140.0	.00000000 00	.92160000 04	.92160000 04
46.	APS HELIUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.2	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HE FNG PNFU	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HF VFH PNFU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	5.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	FNV CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		296314.03	352.82	0.9	-0.5	.48564538 09	.12728238 11	.12725673 11
						SLF .10482173 06	SLF .27472638 07	SLF .27465807 07

S-IVB 90 PERCENT THRUST		TIME 147.2				ITEMS REMAINING		
SFO	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
7.	ULLAGE RKT GRN	-0.00	225.80	0.0	0.0	-.52761895 02	-.26596268 02	-.26596268 02
8.	ULLAGE RKT CSE	214.46	222.00	0.4	-0.7	.39328909 07	.19653613 07	.19653613 07
23.	NOSF CONF	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
25.	SLA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	LEM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMENT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMENT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.40248599 06	.10062150 06
30.	S48206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89879915 09
31.	LOX ULLAGE GAS	42.63	317.75	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LOX IN TANK	192319.42	241.57	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LOX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LOX REFLO VALVE	0.00	71.00	0.0	0.0	.36247717 05	.16737127 05	.16737127 05
37.	LH2 ULLAGE GAS	190.55	618.78	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LH2 IN TANK	37444.68	435.97	0.0	0.0	.00000000 00	.12375256 09	.12375256 09
39.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LH2 IN ENGINE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
41.	LH2 REFLO VALVE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
42.	COLD HE QUAD 1	85.72	521.30	86.3	-75.6	.00000000 00	.30298643 05	.30298643 05
43.	COLD HE QUAD 2	171.45	494.30	113.8	20.0	.00000000 00	.15761439 06	.15761439 06
44.	APS PRNP FP 1	64.00	248.00	0.0	-140.0	.00000000 00	.92160000 04	.92160000 04
45.	APS PRNP FP 3	64.00	248.00	0.0	140.0	.00000000 00	.92160000 04	.92160000 04
46.	APS HELIUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.2	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HE FNG PNFU	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HF VFH PNFU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	1.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	FNV CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		295516.95	352.80	0.9	-0.5	.48353436 09	.12723430 11	.12720256 11
						SLF .10436609 06	SLF .27462261 07	SLF .27455410 07

TABLE AP 2-1 (Sheet 3 of 9)
 PREDICTED S-IVB-206 MASS BREAKDOWN SUMMARY

SUMMARY PRINTOUT		TIME 154.5				ITEMS JETTISONED		
SFO	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
7.	ULLAGE RKT GRN	-0.00	225.80	0.0	0.0	-.52761895 02	-.26596268 02	-.26596268 02
8.	ULLAGE RKT CSE	214.46	222.00	0.4	-0.7	.39328909 07	.19653348 07	.19653348 07
TOTAL JETTISONED		214.46	222.00	0.4	-0.7	.39328381 07	.19653348 07	.19653348 07
						SLF .84886405 03	SLF .42419801 03	SLF .42419801 03

SUMMARY PRINTOUT		TIME 154.5				ITEMS REMAINING		
SEQ	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
23.	NOSE CONE	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
25.	SLA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	LEM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMENT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMENT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.40248599 06	.10062150 06
30.	S48206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90063545 09	.89879915 09
31.	LOX ULLAGE GAS	48.43	315.23	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LOX IN TANK	189251.37	240.49	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LOX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LOX RELO VALVE	30.00	71.00	0.0	0.0	.36247727 05	.16737132 05	.16737132 05
37.	LH2 ULLAGE GAS	193.98	615.85	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LH2 IN TANK	36844.65	433.68	0.0	0.0	.00000000 00	.11451684 09	.11451684 09
39.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LH2 IN ENGINE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
41.	LH2 RELO VALVE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
42.	COLD HE QUAD 1	85.09	521.30	86.3	-75.6	.00000000 00	.30072851 05	.30072851 05
43.	COLD HE QUAD 2	170.17	494.30	113.8	20.0	.00000000 00	.15643982 06	.15643982 06
44.	APS PROP FP 1	63.97	248.00	0.0	-140.0	.00000000 00	.92114472 04	.92114472 04
45.	APS PROP FP 3	63.97	248.00	0.0	140.0	.00000000 00	.92114472 04	.92114472 04
46.	APS HELIUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.7	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HE ENG PNFI	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HE VFH PNFI	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	1.88	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	FN2 CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		291642.54	352.90	0.9	-0.5	.47957227 09	.12698468 11	.12695277 11
						SLF .10351091 06	SLF .27408383 07	SLF .27401495 07

SUMMARY PRINTOUT		TIME 200.0				ITEMS REMAINING		
SFO	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
23.	NOSE CONE	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
25.	SLA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	LEM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMENT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMENT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.40248599 06	.10062150 06
30.	S48206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90063545 09	.89879915 09
31.	LOX ULLAGE GAS	48.43	302.08	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LOX IN TANK	168272.88	233.56	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LOX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LOX RELO VALVE	30.00	71.00	0.0	0.0	.36247727 05	.16737132 05	.16737132 05
37.	LH2 ULLAGE GAS	215.37	598.78	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LH2 IN TANK	33047.15	419.11	0.0	0.0	.00000000 00	.14189499 09	.14189499 09
39.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LH2 IN ENGINE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
41.	LH2 RELO VALVE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
42.	COLD HE QUAD 1	80.99	521.30	86.3	-75.6	.00000000 00	.28626061 05	.28626061 05
43.	COLD HE QUAD 2	161.99	494.30	113.8	20.0	.00000000 00	.14891362 06	.14891362 06
44.	APS PROP FP 1	63.66	248.00	0.0	-140.0	.00000000 00	.91664154 04	.91664154 04
45.	APS PROP FP 3	63.66	248.00	0.0	140.0	.00000000 00	.91664154 04	.91664154 04
46.	APS HELIUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.7	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HE ENG PNFI	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HE VFH PNFI	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	7.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	FN2 CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		266916.34	354.40	1.0	-0.5	.47937697 09	.12634395 11	.12631095 11
						SLF .10346876 06	SLF .27270087 07	SLF .27262964 07

TABLE AP 2-1 (Sheet 4 of 9)
 PREDICTED S-IVB-206 MASS BREAKDOWN SUMMARY

SUMMARY PRINTOUT		TIME 300.0				ITEMS REMAINING		
SFO	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
23.	NOSE CONE	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
25.	SLA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	LFM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMENT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMENT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.40248599 06	.10062150 06
30.	S4R206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89879915 09
31.	LX2 ULLAGE GAS	164.17	283.30	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LX2 IN TANK	122078.76	219.74	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LX2 IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LX2 IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LX2 IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LX2 BELO VALVE	30.00	71.00	0.0	0.0	.36247727 05	.16737132 05	.16737132 05
37.	LH2 ULLAGE GAS	262.37	565.80	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LH2 IN TANK	24689.64	386.85	0.0	0.0	.00000000 00	.10530822 09	.10530822 09
39.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LH2 IN ENGINE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
41.	LH2 BELO VALVE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
42.	COLD HE QUAD 1	72.00	521.30	86.3	-75.6	.00000000 00	.25446362 05	.25446362 05
43.	COLD HE QUAD 2	143.99	494.30	113.8	20.0	.00000000 00	.13237251 06	.13237251 06
44.	APS PROP FP 1	62.97	248.00	0.0	-140.0	.00000000 00	.90674440 04	.90674440 04
45.	APS PROP FP 3	62.97	248.00	0.0	140.0	.00000000 00	.90674440 04	.90674440 04
46.	APS HELIUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.2	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HE ENG PNEU	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HF VEH PNEU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	7.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	FNV CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		212462.41	366.41	1.2	-0.6	.47891939 09	.12210108 11	.12206555 11
						.SLF .10337000 06	.SLF .26354307 07	.SLF .26346638 07

SUMMARY PRINTOUT		TIME 400.0				ITEMS REMAINING		
SFO	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
23.	NOSE CONE	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
25.	SLA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	LFM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMENT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMENT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.40248599 06	.10062150 06
30.	S4R206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89879915 09
31.	LX2 ULLAGE GAS	164.17	283.30	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LX2 IN TANK	75882.72	204.96	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LX2 IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LX2 IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LX2 IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LX2 BELO VALVE	30.00	71.00	0.0	0.0	.36247727 05	.16737132 05	.16737132 05
37.	LH2 ULLAGE GAS	309.36	533.21	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LH2 IN TANK	16306.60	354.26	0.0	0.0	.00000000 00	.80925450 08	.80925450 08
39.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LH2 IN ENGINE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
41.	LH2 BELO VALVE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
42.	COLD HE QUAD 1	63.00	521.30	86.3	-75.6	.00000000 00	.22266544 05	.22266544 05
43.	COLD HE QUAD 2	126.00	494.30	113.8	20.0	.00000000 00	.11583142 06	.11583142 06
44.	APS PROP FP 1	62.28	248.00	0.0	-140.0	.00000000 00	.89684729 04	.89684729 04
45.	APS PROP FP 3	62.28	248.00	0.0	140.0	.00000000 00	.89684729 04	.89684729 04
46.	APS HELIUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.2	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HE ENG PNEU	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HF VEH PNEU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	7.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	FNV CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		157982.01	397.65	1.6	-0.8	.47841201 09	.11374275 11	.11370442 11
						.SLF .10326048 06	.SLF .24550243 07	.SLF .24541971 07

TABLE AP 2-1 (Sheet 5 of 9)
 PREDICTED S-IVB-206 MASS BREAKDOWN SUMMARY

EMR CUTBACK		TIME 438.9				ITEMS REMAINING		
SEQ	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
23.	NOSE CONE	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
25.	SLA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	LEM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMNT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMNT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.46248599 06	.10062150 06
30.	S4R206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89879915 09
31.	LOX ULLAGE GAS	274.67	263.32	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LOX IN TANK	57910.07	198.34	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LOX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LOX RFLW VALVE	30.00	71.00	0.0	0.0	.36247727 05	.16737132 05	.16737132 05
37.	LH2 ULLAGE GAS	327.65	520.26	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LH2 IN TANK	13059.35	341.32	0.0	0.0	.00000000 00	.68860482 08	.68860482 08
39.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LH2 IN ENGINE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
41.	LH2 RFLW VALVE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
42.	COLD HF QUAD 1	59.50	521.30	86.3	-75.6	.00000000 00	.21029618 05	.21029618 05
43.	COLD HF QUAD 2	119.00	494.30	113.8	20.0	.00000000 00	.10939693 06	.10939693 06
44.	APS PRDP FP 1	62.01	248.00	0.0	-140.0	.00000000 00	.89299731 04	.89299731 04
45.	APS PRDP FP 3	62.01	248.00	0.0	140.0	.00000000 00	.89299731 04	.89299731 04
46.	APS HELIUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.2	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HF ENG PNFU	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HF VFH PNFU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	7.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	FNW CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		136800.30	419.90	1.8	-1.0	.47818844 09	.10788059 11	.10788054 11
						SLF .10321223 06	SLF .23284847 07	SLF .23276310 07

SUMMARY PRINTOUT		TIME 500.0				ITEMS REMAINING		
SEQ	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
23.	NOSE CONE	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
25.	SLA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	LEM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMNT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMNT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.46248599 06	.10062150 06
30.	S4R206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89879915 09
31.	LOX ULLAGE GAS	273.27	256.26	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LOX IN TANK	34539.15	188.24	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LOX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LOX RFLW VALVE	30.00	71.00	0.0	0.0	.36247727 05	.16737132 05	.16737132 05
37.	LH2 ULLAGE GAS	381.18	501.25	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LH2 IN TANK	8228.94	320.88	0.0	0.0	.00000000 00	.46917637 08	.46917637 08
39.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LH2 IN ENGINE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
41.	LH2 RFLW VALVE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
42.	COLD HF QUAD 1	54.74	521.30	86.3	-75.6	.00000000 00	.19345989 05	.19345989 05
43.	COLD HF QUAD 2	109.47	494.30	113.8	20.0	.00000000 00	.10063838 06	.10063838 06
44.	APS PRDP FP 1	61.59	248.00	0.0	-140.0	.00000000 00	.88695017 04	.88695017 04
45.	APS PRDP FP 3	61.59	248.00	0.0	140.0	.00000000 00	.88695017 04	.88695017 04
46.	APS HELIUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.2	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HF ENG PNFU	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HF VFH PNFU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	7.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	FNW CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		108685.97	466.16	2.3	-1.2	.47784026 09	.95453378 10	.95411951 10
						SLF .10313708 06	SLF .20602664 07	SLF .20593722 07

TABLE AP 2-1 (Sheet 6 of 9)
 PREDICTED S-IVB-206 MASS BREAKDOWN SUMMARY

S-IVB ECC		TIME 586.4				ITEMS REMAINING		
SEQ	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
23.	NOSF CONE	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
25.	SIA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	LFM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMNT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMNT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.40248599 06	.10062150 06
30.	S4R206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89879915 09
31.	LOX ULLAGE GAS	392.00	245.61	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LOX IN TANK	2774.42	165.14	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LOX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LOX REFLD VALVE	30.00	71.00	0.0	0.0	.36247727 05	.16737132 05	.16737132 05
37.	HM2 ULLAGE GAS	460.00	475.48	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	HM2 IN TANK	1445.88	278.90	0.0	0.0	.00000000 00	.11078632 08	.11078632 08
39.	HM2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	HM2 IN ENGINE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
41.	HM2 REFLD VALVE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
42.	COID HF QUAD 1	48.00	521.30	86.3	-75.6	.00000000 00	.16965125 05	.16965125 05
43.	COID HF QUAD 2	96.00	494.30	113.8	20.0	.00000000 00	.88253057 05	.88253057 05
44.	APS PROP FP 1	61.00	248.00	0.0	-140.0	.00000000 00	.87839906 04	.87839906 04
45.	APS PROP FP 3	61.00	248.00	0.0	140.0	.00000000 00	.87839906 04	.87839906 04
46.	APS HEI IUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.2	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HF ENG PNEU	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HF VEH PNEU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	7.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	FNV CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		70264.34	603.64	3.5	-1.9	.47717154 09	.56461712 10	.56416696 10
						SLF .10299274 06	SLF .12186700 07	SLF .12176984 07

S-IVB ETD*		TIME 587.7				ITEMS REMAINING		
SEQ	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
23.	NOSF CONE	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
25.	SIA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	LFM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMNT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMNT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.40248599 06	.10062150 06
30.	S4R206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89879915 09
31.	LOX ULLAGE GAS	393.65	245.56	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LOX IN TANK	2645.42	164.89	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LOX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LOX REFLD VALVE	30.00	71.00	0.0	0.0	-.83540605-01	-.38574284-01	-.38574284-01
37.	HM2 ULLAGE GAS	460.00	475.37	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	HM2 IN TANK	1418.88	278.62	0.0	0.0	.00000000 00	.10869205 08	.10869205 08
39.	HM2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	HM2 IN ENGINE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
41.	HM2 REFLD VALVE	0.00	71.00	0.0	0.0	-.28663070-01	-.13234970-01	-.13234970-01
42.	COID HF QUAD 1	48.00	521.30	86.3	-75.6	.00000000 00	.16965125 05	.16965125 05
43.	COID HF QUAD 2	96.00	494.30	113.8	20.0	.00000000 00	.88253057 05	.88253057 05
44.	APS PROP FP 1	61.00	248.00	0.0	-140.0	.00000000 00	.87839906 04	.87839906 04
45.	APS PROP FP 3	61.00	248.00	0.0	140.0	.00000000 00	.87839906 04	.87839906 04
46.	APS HEI IUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.2	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HF ENG PNEU	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HF VEH PNEU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	7.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	FNV CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		70069.99	604.86	3.5	-1.9	.47712017 09	.56079125 10	.56034093 10
						SLF .10298165 06	SLF .12104122 07	SLF .12094403 07

*END OF THRUST DECAY

TABLE AP 2-1 (Sheet 7 of 9)
 PREDICTED S-IVB-206 MASS BREAKDOWN SUMMARY

SUMMARY PRINTOUT		TIME 1,000.0				ITEMS REMAINING		
SFO	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
23.	NOSE CONF	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
25.	SLA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	LFM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMNT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMNT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.40248599 06	.10762150 06
30.	S4B206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89479915 09
31.	LOX ULLAGE GAS	542.00	245.56	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LOX IN TANK	2636.22	164.87	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LOX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LOX RELO VALVE	-0.00	71.00	0.0	0.0	-.83540605-01	-.38574284-01	-.38574284-01
37.	LOX ULLAGE GAS	380.00	475.05	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LOX IN TANK	1338.88	277.79	0.0	0.0	.00000000 00	.10249497 08	.10249497 08
39.	LOX IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LOX IN ENGINE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
41.	LOX RELO VALVE	-0.00	71.00	0.0	0.0	-.28663070-01	-.13234970-01	-.13234970-01
42.	COLD HE QUAD 1	48.00	521.30	86.3	-75.6	.00000000 00	.16965125 05	.16965125 05
43.	COLD HE QUAD 2	96.00	494.30	113.8	20.0	.00000000 00	.88253057 05	.88253057 05
44.	APS PROP FP 1	61.00	248.00	0.0	-140.0	.00000000 00	.87839906 04	.87839906 04
45.	APS PROP FP 3	61.00	248.00	0.0	140.0	.00000000 00	.87839906 04	.87839906 04
46.	APS HELIUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.2	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIP HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HE ENG PNEU	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HE VEH PNEU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	7.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	ENV CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		70049.14	604.66	3.5	-1.9	.47711985 09	.56156056 10	.56111021 10
						SLF .10298158 06	SLF .12120727 07	SLF .12111007 07

SUMMARY PRINTOUT		TIME 1,500.0				ITEMS REMAINING		
SFO	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
23.	NOSE CONF	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
25.	SLA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	LFM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMNT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMNT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.40248599 06	.10762150 06
30.	S4B206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89479915 09
31.	LOX ULLAGE GAS	542.00	245.56	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LOX IN TANK	2624.72	164.85	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LOX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LOX RELO VALVE	-0.00	71.00	0.0	0.0	-.83540605-01	-.38574284-01	-.38574284-01
37.	LOX ULLAGE GAS	380.00	474.64	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LOX IN TANK	1238.88	276.74	0.0	0.0	.00000000 00	.94765041 07	.94765041 07
39.	LOX IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LOX IN ENGINE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
41.	LOX RELO VALVE	-0.00	71.00	0.0	0.0	-.28663070-01	-.13234970-01	-.13234970-01
42.	COLD HE QUAD 1	48.00	521.30	86.3	-75.6	.00000000 00	.16965125 05	.16965125 05
43.	COLD HE QUAD 2	96.00	494.30	113.8	20.0	.00000000 00	.88253057 05	.88253057 05
44.	APS PROP FP 1	61.00	248.00	0.0	-140.0	.00000000 00	.87839906 04	.87839906 04
45.	APS PROP FP 3	61.00	248.00	0.0	140.0	.00000000 00	.87839906 04	.87839906 04
46.	APS HELIUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.2	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIP HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HE ENG PNEU	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HE VEH PNEU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	7.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	ENV CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		69937.64	605.17	3.5	-1.9	.47711810 09	.56028549 10	.55983506 10
						SLF .10298120 06	SLF .12093206 07	SLF .12083484 07

TABLE AP 2-1 (Sheet 8 of 9)
 PREDICTED S-IVB-206 MASS BREAKDOWN SUMMARY

NOSE CONE SEPARATION		TIME 2,000.0				ITEMS JETTISONED		
SFO	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
23.	NOSF CONF	1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
TOTAL JETTISONED		1400.00	1096.90	0.0	0.0	.53989739 07	.23810326 07	.23810326 07
						SLF .11653149 04	SLF .51393260 03	SLF .51393260 03

NOSE CONE SEPARATION		TIME 2,000.0				ITEMS REMAINING		
SFO	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
25.	SLA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
26.	LFM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	858.00	0.6	-2.3	.42593132 08	.60032840 08	.58657785 08
28.	INSTRUMNT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMNT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.40248599 06	.10062150 06
30.	S4B206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89879915 09
31.	LOX ULLAGE GAS	542.00	245.55	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LOX IN TANK	2613.22	164.81	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LOX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LOX BFLV VALVE	-0.00	71.00	0.0	0.0	-.83540605-01	-.38574284-01	-.38574284-01
37.	LH2 ULLAGE GAS	380.00	473.90	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LH2 IN TANK	1138.88	275.66	0.0	0.0	.00000000 00	.87052228 07	.87052228 07
39.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LH2 IN ENGINE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
41.	LH2 BFLV VALVE	-0.00	71.00	0.0	0.0	-.28663070-01	-.13234970-01	-.13234970-01
42.	COID HE QUAD 1	48.00	521.30	86.3	-75.6	.00000000 00	.16965125 05	.16965125 05
43.	COID HE QUAD 2	96.00	494.30	113.8	20.0	.00000000 00	.88253057 05	.88253057 05
44.	APS PRNP FP 1	61.00	248.00	0.0	-140.0	.00000000 00	.87839906 04	.87839906 04
45.	APS PRNP FP 3	61.00	248.00	0.0	140.0	.00000000 00	.87839906 04	.87839906 04
46.	APS HEI IUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.2	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HE ENG PNEU	7.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HE VEH PNEU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	7.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	ENV CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		68426.14	595.65	3.6	-1.9	.47169482 09	.52428620 10	.52383444 10
						SLF .10181064 06	SLF .11316197 07	SLF .11306446 07

SUMMARY PRINTOUT		TIME 2,398.9				ITEMS JETTISONED		
SFO	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
25.	SLA RING	75.00	839.70	0.0	-1.8	.43594031 06	.23478018 06	.20124300 06
TOTAL JETTISONED		75.00	839.70	0.0	-1.8	.43594031 06	.23478118 06	.20124400 06
						SLF .94093387 02	SLF .50675187 02	SLF .43436518 02

SUMMARY PRINTOUT		TIME 2,398.9				ITEMS REMAINING		
SFO	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
26.	LFM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
27.	ADAPTER	3625.00	839.70	1.4	-4.6	.11832171 09	.82268466 08	.78612835 08
28.	INSTRUMNT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMNT NO 2	150.00	691.60	105.5	-51.6	.50303520 06	.40248599 06	.10062150 06
30.	S4B206 DRY STG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89879915 09
31.	LOX ULLAGE GAS	542.00	245.55	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LOX IN TANK	2604.04	164.81	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29250000 04	.32500000 03
34.	LOX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LOX BFLV VALVE	-0.00	71.00	0.0	0.0	-.83540605-01	-.38574284-01	-.38574284-01
37.	LH2 ULLAGE GAS	380.00	473.90	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LH2 IN TANK	1059.10	274.76	0.0	0.0	.00000000 00	.80910390 07	.80910390 07
39.	LH2 IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LH2 IN ENGINE	10.00	71.00	0.0	0.0	.12082576 05	.55790439 04	.55790439 04
41.	LH2 BFLV VALVE	-0.00	71.00	0.0	0.0	-.28663070-01	-.13234970-01	-.13234970-01
42.	COID HE QUAD 1	48.00	521.30	86.3	-75.6	.00000000 00	.16965125 05	.16965125 05
43.	COID HE QUAD 2	96.00	494.30	113.8	20.0	.00000000 00	.88253057 05	.88253057 05
44.	APS PRNP FP 1	61.00	248.00	0.0	-140.0	.00000000 00	.87839906 04	.87839906 04
45.	APS PRNP FP 3	61.00	248.00	0.0	140.0	.00000000 00	.87839906 04	.87839906 04
46.	APS HEI IUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD RESERVE	2.00	135.80	-37.2	10.7	.00000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HE ENG PNEU	7.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HE VEH PNEU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	7.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	ENV CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		68262.19	594.82	3.6	-2.1	.54659418 09	.52169724 10	.52101669 10
						SLF .11806326 06	SLF .11240317 07	SLF .11245628 07

TABLE AP 2-1 (Sheet 9 of 9)
 PREDICTED S-IVB-206 MASS BREAKDOWN SUMMARY

LM SEPARATION		TIME 3,124.8				ITEMS JETTISONED		
SFO	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
26.	IFM	33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
TOTAL JETTISONED		33500.00	794.50	1.0	-0.7	.11160855 09	.12555426 09	.12555426 09
						SLF .24089596 05	SLF .27099640 05	SLF .27099640 05

LM SEPARATION		TIME 3,124.8				ITEMS REMAINING		
SFO	DESCRIPTION	MASS	STATION (INCHES)			MOI (POUND INCHES SQUARE)		
		(POUNDS)	H. ARM	L. ARM	V. ARM	ROLL	PITCH	YAW
27.	ADAPTER	3625.00	839.70	1.4	-4.6	.11832171 09	.82268466 08	.78612835 08
28.	INSTRUMNT UNIT	4000.00	699.10	-3.1	-8.1	.60162278 08	.32869690 08	.30450250 08
29.	EXPERIMNT NO 2	150.00	691.60	135.5	-51.6	.50303520 06	.40248599 06	.10762150 06
30.	S4B206 DEY SIG	21676.00	315.73	8.8	-2.5	.24816852 09	.90003545 09	.89879915 09
31.	LOX ULLAGE GAS	542.00	245.54	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
32.	LOX IN TANK	2587.35	164.78	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
33.	LOX IN PORTS	13.00	155.00	-25.0	10.0	.18720000 04	.29253000 04	.32500000 03
34.	LOX IN LINES	246.00	136.80	6.4	-9.9	.22718616 05	.22718616 05	.22718616 05
35.	LOX IN ENGINE	108.00	71.00	0.0	0.0	.13049182 06	.60253674 05	.60253674 05
36.	LOX RELV VALVE	-0.00	71.00	0.0	0.0	-.83540005-01	-.38574284-01	-.38574284-01
37.	LOX ULLAGE GAS	380.00	473.30	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
38.	LOX IN TANK	913.92	273.03	0.0	0.0	.00000000 00	.69757569 07	.69757569 07
39.	LOX IN LINES	38.00	187.91	-59.9	-64.8	.44993827 05	.48051516 05	.48051516 05
40.	LOX IN ENGINE	10.00	71.00	0.0	0.0	.12082574 05	.55790439 04	.55790439 04
41.	LOX RELV VALVE	-0.00	71.00	0.0	0.0	-.28663070-01	-.13234970-01	-.13234970-01
42.	COLD HE QUAD 1	48.00	521.30	86.3	-75.6	.00000000 00	.16965125 05	.16965125 05
43.	COLD HE QUAD 2	96.00	494.30	113.8	20.0	.00000000 00	.88253057 05	.88253057 05
44.	APS PROP FP 1	61.00	248.00	0.0	-140.0	.00000000 00	.87839906 04	.87839906 04
45.	APS PROP FP 3	61.00	248.00	0.0	140.0	.00000000 00	.87839906 04	.87839906 04
46.	APS HELIUM	3.00	248.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
47.	HYDRAULIC OIL	15.00	110.00	-4.2	6.0	.86400000 04	.33750000 04	.33750000 04
48.	N2 HYD FESERVF	2.00	135.80	-37.2	10.7	.60000000 00	.00000000 00	.00000000 00
49.	AIR HYD PUMP	0.50	130.00	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
50.	HE ENG PNFU	2.55	88.40	0.0	0.0	.00000000 00	.00000000 00	.00000000 00
51.	HE VEH PNFU	1.00	164.60	61.0	17.5	.00000000 00	.00000000 00	.00000000 00
52.	GH2 START TANK	7.00	84.00	-22.4	14.6	.00000000 00	.00000000 00	.00000000 00
53.	FNW CONT FLUID	14.00	662.70	0.0	0.0	.21526400 06	.10760440 06	.10760440 06
TOTAL REMAINING		34600.31	402.99	6.2	-3.4	.43480703 09	.24643775 10	.24572408 10
						SLF .93849780 05	SLF .53191142 06	SLF .53337103 06

TABLE AP 2-2 (Sheet 1 of 2)
 PREDICTED S-IVB-206 MASS CHARACTERISTICS SUMMARY

TIME (SECONDS)	MASS (POUNDS)	H. ARM (INCHES)	L. ARM (INCHES)	V. ARM (INCHES)	ROLL MOI (SLUG FT. SQ.)	PITCH MOI (SLUG FT. SQ.)	YAW MOI (SLUG FT. SQ.)
0.000	296519.20	352.79	0.9	-0.5	105618.76	2748340.97	2747657.81
100.000	296419.20	352.77	0.9	-0.5	105253.41	2747929.88	2747246.75
142.400	296419.20	352.77	0.9	-0.5	105253.41	2747929.88	2747246.75
142.500	296414.56	352.77	0.9	-0.5	105233.28	2747903.63	2747220.47
142.500	296378.88	352.79	0.9	-0.5	105103.61	2747634.03	2746950.84
143.900	296314.03	352.82	0.9	-0.5	104821.82	2747266.22	2746583.03
146.200	295907.96	352.82	0.9	-0.5	104364.01	2746573.22	2745888.72
147.200	295516.95	352.80	0.9	-0.5	104366.18	2746228.47	2745543.38
149.900	294257.04	352.79	0.9	-0.5	104364.07	2744682.16	2743995.63
150.000	294209.91	352.79	0.9	-0.5	104363.98	2744625.06	2743938.53
154.500	291857.00	352.81	0.9	-0.5	104359.88	2742057.59	2741369.75
154.500	291642.54	352.90	0.9	-0.5	103511.00	2740840.72	2740151.88
197.200	268440.89	354.25	0.9	-0.5	103471.52	2728891.75	2728180.97
200.000	266916.34	354.40	1.0	-0.5	103468.85	2727011.09	2726298.81
210.000	261469.15	355.04	1.0	-0.5	103459.26	2720018.97	2719301.38
220.000	256026.27	355.79	1.0	-0.5	103449.63	2712604.50	2711881.59
230.000	250579.81	356.65	1.0	-0.5	103439.93	2704751.38	2704023.13
240.000	245132.72	357.63	1.0	-0.5	103430.17	2696447.13	2695713.41
250.000	239689.58	358.74	1.1	-0.6	103420.35	2687674.91	2686935.78
260.000	234241.65	359.98	1.1	-0.6	103410.46	2678393.50	2677648.91
270.000	228794.88	361.36	1.1	-0.6	103400.49	2668575.47	2667825.38
280.000	223353.51	362.88	1.1	-0.6	103390.45	2658185.63	2657429.97
290.000	217910.30	364.56	1.2	-0.6	103380.31	2647159.75	2646398.50
300.000	212467.41	366.41	1.2	-0.6	103370.08	2635432.94	2634666.06
310.000	207013.58	368.43	1.2	-0.6	103359.76	2622947.69	2622175.09
320.000	201565.38	370.63	1.2	-0.7	103349.32	2609636.50	2608858.16
330.000	196119.76	373.04	1.3	-0.7	103338.77	2595416.94	2594632.78
340.000	190672.37	375.67	1.3	-0.7	103328.09	2580179.50	2579389.44
350.000	185221.60	378.59	1.3	-0.7	103317.26	2563161.63	2562365.59
360.000	179770.52	381.76	1.4	-0.7	103306.29	2545022.97	2544220.91
370.000	174321.40	385.22	1.4	-0.8	103295.15	2525358.13	2524549.91
380.000	168874.24	388.99	1.5	-0.8	103283.83	2503961.19	2503146.72
390.000	163428.99	393.12	1.5	-0.8	103272.31	2480607.41	2479786.66
400.000	157982.01	397.65	1.6	-0.8	103260.57	2455026.50	2454199.25
438.900	136800.30	419.90	1.8	-1.0	103212.32	2328486.72	2327633.00
443.900	134198.24	423.24	1.8	-1.0	103206.36	2309327.50	2308470.56
450.000	131211.68	427.26	1.9	-1.0	103199.16	2286248.09	2285387.25
460.000	126564.61	433.95	1.9	-1.0	103187.34	2247769.53	2246902.34
470.000	122052.27	441.02	2.0	-1.1	103175.33	2206927.09	2206053.44
480.000	117588.35	448.66	2.1	-1.1	103163.01	2162615.06	2161734.75
490.000	113142.48	456.99	2.2	-1.2	103150.31	2114052.41	2113165.34
500.000	108685.97	466.16	2.3	-1.2	103137.17	2060268.19	2059374.02
510.000	104223.45	476.21	2.4	-1.3	103123.51	2001436.36	2000534.88
520.000	99772.17	487.38	2.5	-1.3	103109.29	1934801.27	1933892.16

TABLE AP 2-2 (Sheet 2 of 2)
 PREDICTED S-IVB-206 MASS CHARACTERISTICS SUMMARY

TIME (SECONDS)	MASS (POUNDS)	H. ARM (INCHES)	L. ARM (INCHES)	V. ARM (INCHES)	ROLL MOI (SLUG FT. SQ.)	PITCH MOI (SLUG FT. SQ.)	YAW MOI (SLUG FT. SQ.)
530.000	95338.27	499.76	2.6	-1.4	103094.47	1860300.42	1859383.33
540.000	90913.45	513.42	2.7	-1.5	103078.93	1780204.53	1779279.09
550.000	86488.59	528.59	2.8	-1.5	103062.54	1687909.67	1686975.47
560.000	82050.97	545.75	3.0	-1.6	103045.14	1582458.77	1581515.20
570.000	77593.07	565.32	3.1	-1.7	103026.52	1460570.22	1459616.67
580.000	73124.98	587.65	3.3	-1.8	103006.50	1320125.06	1319160.77
586.400	70264.34	603.64	3.5	-1.9	102992.83	1218671.05	1217699.42
586.600	70234.19	603.83	3.5	-1.9	102991.12	1217397.27	1216425.59
587.700	70069.99	604.86	3.5	-1.9	102981.74	1210413.28	1209441.30
596.400	70083.01	604.79	3.5	-1.9	102981.79	1210776.03	1209804.09
600.000	70085.20	604.77	3.5	-1.9	102981.79	1210914.63	1209942.67
686.400	70118.48	604.34	3.5	-1.9	102981.91	1213766.45	1212794.58
686.800	70118.99	604.33	3.5	-1.9	102981.91	1213781.06	1212809.20
700.000	70116.04	604.35	3.5	-1.9	102981.90	1213709.36	1212737.47
800.000	70093.74	604.45	3.5	-1.9	102981.82	1213165.44	1212193.52
900.000	70071.44	604.55	3.5	-1.9	102981.75	1212620.22	1211648.27
1000.000	70049.14	604.66	3.5	-1.9	102981.67	1212073.75	1211101.73
1100.000	70026.84	604.76	3.5	-1.9	102981.59	1211526.02	1210553.95
1200.000	70004.54	604.86	3.5	-1.9	102981.52	1210976.81	1210004.70
1300.000	69982.24	604.97	3.5	-1.9	102981.44	1210426.52	1209454.39
1400.000	69959.94	605.07	3.5	-1.9	102981.37	1209874.58	1208902.41
1500.000	69937.64	605.17	3.5	-1.9	102981.29	1209321.64	1208349.44
1600.000	69915.34	605.28	3.5	-1.9	102981.22	1208767.48	1207795.22
1700.000	69893.04	605.38	3.5	-1.9	102981.14	1208211.67	1207239.36
1800.000	69870.74	605.49	3.5	-1.9	102981.07	1207654.59	1206682.25
1900.000	69848.44	605.59	3.5	-1.9	102980.99	1207096.36	1206123.98
2000.000	69826.14	605.70	3.5	-1.9	102980.91	1206537.11	1205564.69
2000.000	68426.14	595.65	3.6	-1.9	101810.73	1131620.69	1130645.61
2100.000	68403.84	595.75	3.6	-1.9	101810.65	1131091.34	1130116.23
2200.000	68381.54	595.85	3.6	-1.9	101810.57	1130560.50	1129585.34
2300.000	68359.24	595.96	3.6	-1.9	101810.50	1130028.59	1129053.39
2398.899	68337.19	596.06	3.6	-1.9	101810.42	1129501.45	1128526.22
2398.900	68337.19	595.09	3.6	-2.1	118157.67	1127053.14	1125577.19
2398.900	68262.19	594.82	3.6	-2.1	118063.36	1126032.67	1124563.77
2400.000	68261.94	594.82	3.6	-2.1	118063.36	1126026.73	1124557.83
2500.000	68239.64	594.93	3.6	-2.1	118063.28	1125496.22	1124027.25
2600.000	68217.34	595.03	3.6	-2.1	118063.20	1124964.66	1123495.66
2700.000	68195.04	595.14	3.6	-2.1	118063.11	1124431.52	1122962.47
2800.000	68172.74	595.24	3.6	-2.1	118063.03	1123897.39	1122428.31
2900.000	68150.44	595.34	3.6	-2.1	118062.95	1123362.16	1121893.05
3000.000	68128.14	595.45	3.6	-2.1	118062.86	1122825.75	1121356.58
3124.800	68100.31	595.58	3.6	-2.1	118062.76	1122154.41	1120685.19
3124.800	34600.31	402.99	6.2	-3.4	93848.86	531911.88	530371.49
3200.000	34583.54	403.05	6.2	-3.4	93848.68	531820.65	530280.16

TABLE AP 2-3 (Sheet 1 of 3)
 DEFINITIONS FOR MASS CHARACTERISTICS
 COMPUTER PROGRAM WS11 PRINTOUTS

TERM	DEFINITIONS	UNITS
DAC Station	Distance along the H axis from an arbitrary S-IVB stage reference zero. The zero station is located so that the S-IVB stage engine gimbal point is station 100.0. Positive values increase in the forward direction and negative values are aft of station zero.	Inches
H Arm	Distance along the centerline of the S-IVB stage from the center of gravity of the item under consideration to DAC station zero.	Inches
Items Jettisoned	A listing of all items being considered at the current computing time that will not be considered at the next computing time.	None
Items Remaining	A listing of all items being considered at the current computing time that will be considered at the next computing time.	None
L Arm	Distance from the center of gravity of the item under consideration to the centerline of the S-IVB stage along an axis perpendicular to the centerline and coinciding with position II and IV. Position II is positive and position IV is negative.	Inches

TABLE AP 2-3 (Sheet 2 of 3)
 DEFINITIONS FOR MASS CHARACTERISTICS
 COMPUTER PROGRAM WS11 PRINTOUTS

TERM	DEFINITIONS	UNITS
Pitch MOI	Moment of inertia of any item or total about an axis through its own center of gravity and parallel to the V axis.	Lbm-In ²
Pound Inches Square	Moment of inertia about the center of gravity of each item or total of items.	Lbm-In ²
SLF	Slug feet squared	
SLG	Slugs	
SS	Center of gravity expressed in terms of stage coordinates when individual items are in another coordinate system.	Inches
Time	Time is referenced to range time. All computing was done in the pounds, inches, and pound-inches squared system of units. (Items below the TOTAL REMAINING line were converted to other unit systems.) Pound mass is defined as 1/32.174 slugs.	Seconds
Total Jettisoned	A summation of the items being jettisoned at the current computing time.	None
Total Remaining	A summation of the items remaining	None
V Arm	Distance from the center of gravity of item under consideration to the centerline of the stage along an axis perpendicular to the H and L axes and coinciding with positions I and III. Position I is negative and position III is positive.	Inches

TABLE AP 2-3 (Sheet 3 of 3)
 DEFINITIONS FOR MASS CHARACTERISTICS
 COMPUTER PROGRAM WS11 PRINTOUTS

TERM	DEFINITIONS	UNITS
VS	Vehicle station (when center of gravity is expressed in coordinates other than S-IVB stage).	Inches
Yaw MOI	Moment of inertia of any item or total, about an axis through its own center of gravity and parallel to the L axis.	Lbm-In ²

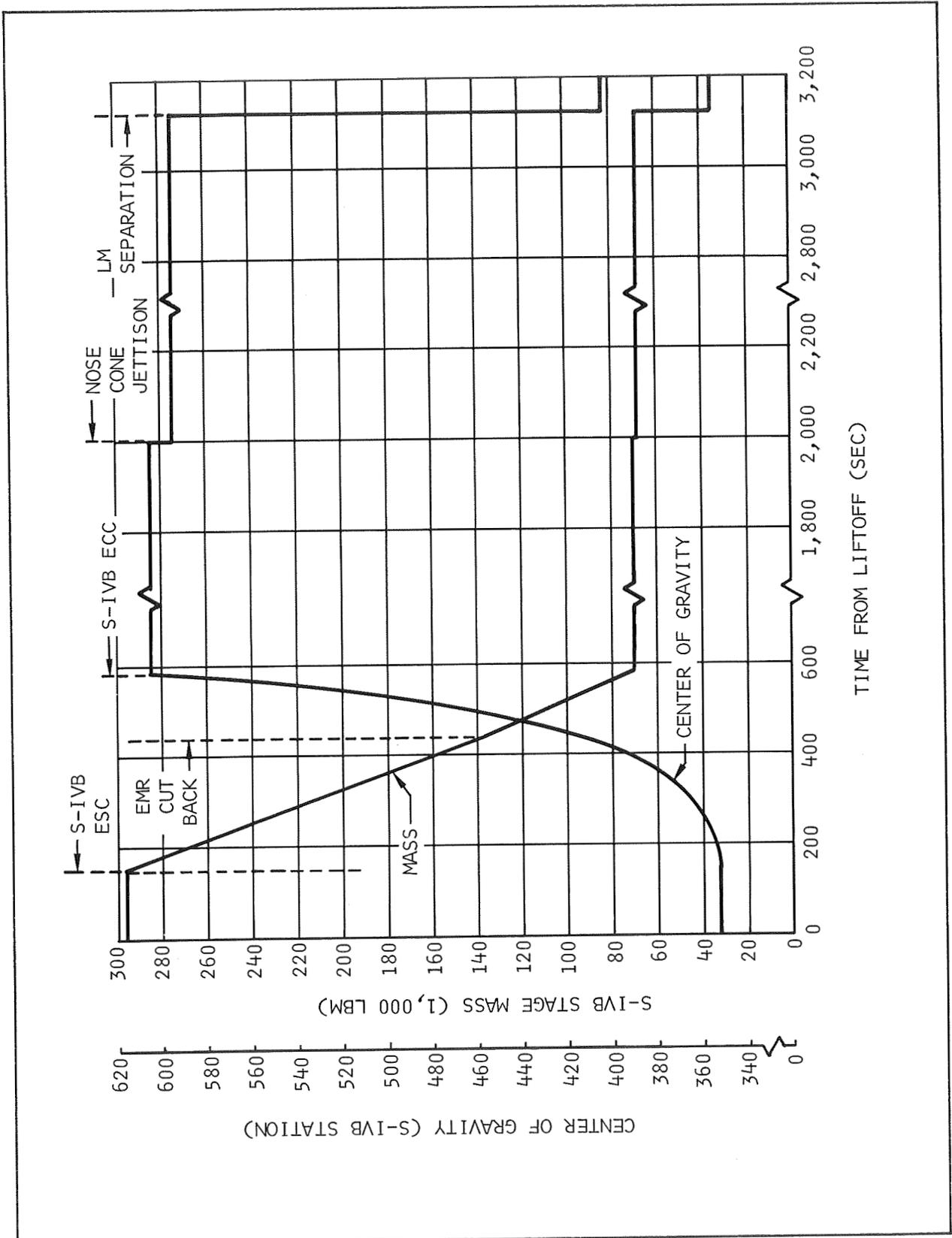


Figure AP 2-1. S-IVB-206 Stage Mass and Center of Gravity

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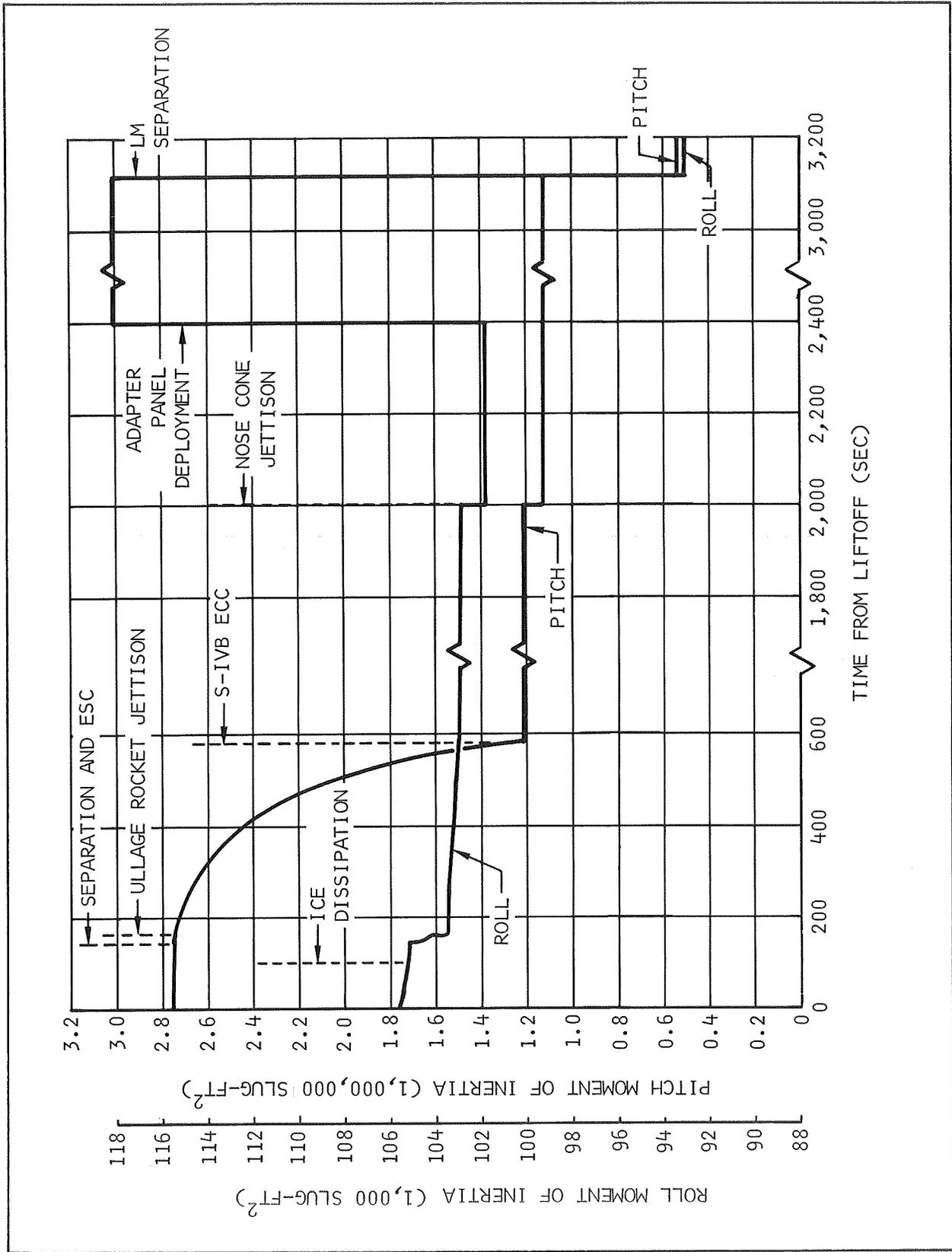


Figure AP 2-2. S-IVB-206 Stage Mass Moment of Inertia

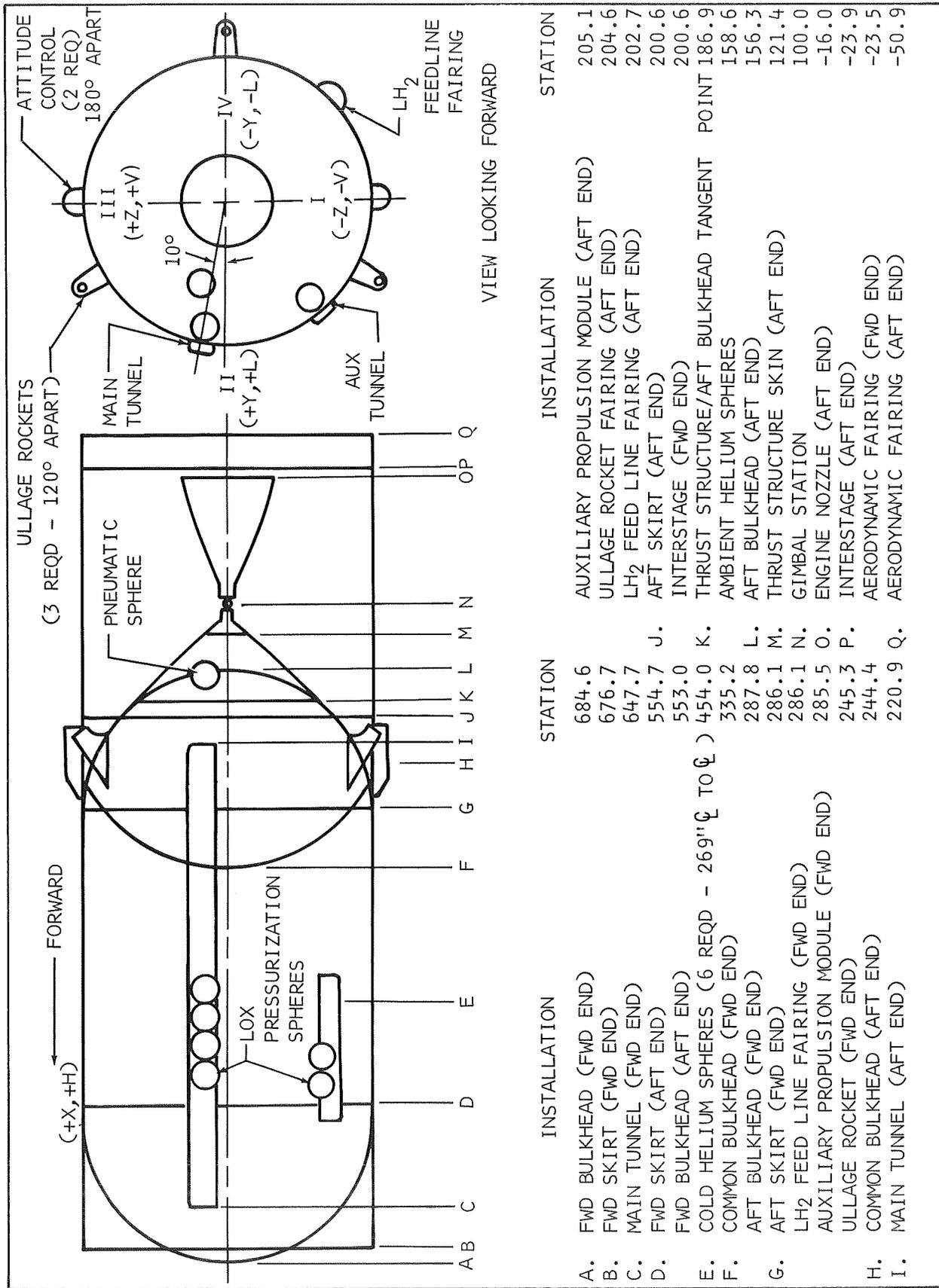
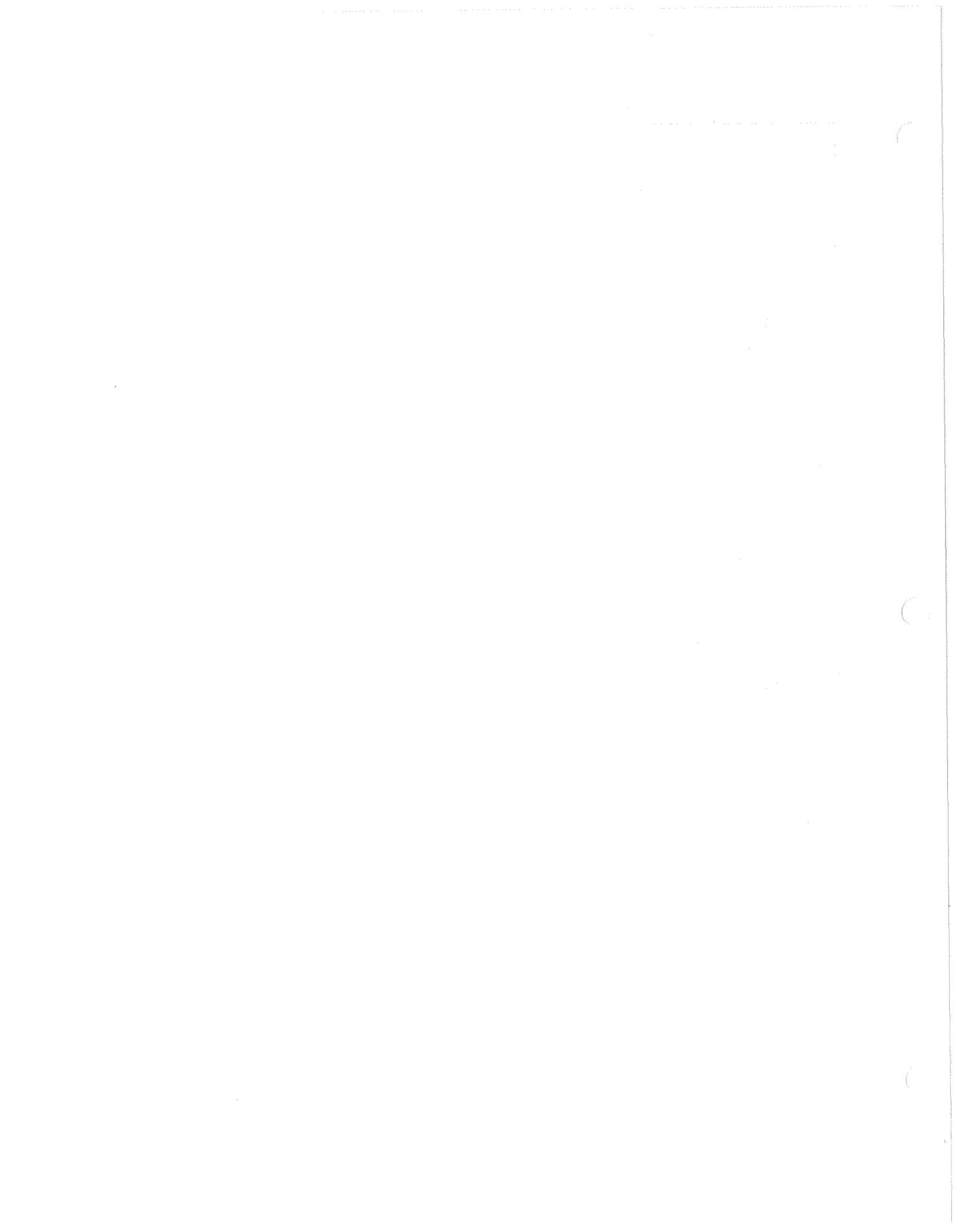


Figure AP 2-3. S-IVB-206 Stage Station Numbers



3. PREDICTED FLIGHT TRAJECTORY

As of the publication date of this document, DAC has not been provided sufficient data to generate S-IB or S-IVB trajectories. Therefore, this information will be supplied in a subsequent revision.

4. TELEMETRY LOOK ANGLES AND TELEMETRY POWER MARGINS

As of the publication date of this document, DAC has not been provided with the trajectories necessary to establish the data for this appendix. Therefore, this information will be included in a subsequent revision.

5. PREDICTED PROPULSION SYSTEM PERFORMANCE

This appendix presents the predicted propulsion system performance in support of the applicable S-IVB-206 mission objectives (paragraph 2.1) and the stage objectives (section 3). The predictions are presented in accordance with the requirements of NASA/MSFC contract letter I-V-S-IVB-TD-66-45, dated 7 July 1966 (reference 14).

Table AP 5-1 lists various predicted parameters of performance for the propulsion system and were derived from the AA89 computer program printout. Table AP 5-2 presents the J-2 engine tag values used for the predictions of table AP 5-1, and contained in table AP 5-3 are the pressurization limits and pressurant flowrates. Table AP 5-4 contains the AA89 computer program printout and table AP 5-5 defines the printout symbols used in table AP 5-4. Figures AP 5-1 through AP 5-31 are graphical presentations of the computer program and were produced by the SC-4020 plotter.

The tables and figures presented in this appendix are based on data from the S-IVB-206 stage acceptance firing at the Sacramento Test Center and on Rocketdyne engine tag values.

TABLE AP 5-1 (Sheet 1 of 2)
 PREDICTED PERFORMANCE PARAMETERS, S-IVB-206 PROPULSION SYSTEM

PARAMETER	UNIT	VALUE	DISPERSION 3 σ
Average Stage			
Longitudinal Thrust (Note 1)	1bf	216,984	$\pm 5,500$
Before PU Valve Cutback (Note 2)	1bf	229,376	$\pm 5,250$
After PU Valve Cutback (Note 3)	1bf	196,792	$\pm 16,000$
Average LOX Flowrate (Note 1)			
Before PU Valve Cutback (Note 2)	1bm/sec	430.5	± 18.2
After PU Valve Cutback (Note 3)	1bm/sec	460.6	± 10.7
Average LH2 Flowrate (Note 1)			
Before PU Valve Cutback (Note 2)	1bm/sec	81.9	± 3.2
After PU Valve Cutback (Note 3)	1bm/sec	83.4	± 2.6
Average Stage Mass			
Flowrate (Note 1)	1bm/sec	512.4	± 18.5
Before PU Valve Cutback (Note 2)	1bm/sec	544.0	± 11.0
After PU Valve Cutback (Note 3)	1bm/sec	460.9	± 33.5
Average Stage Longitudinal			
Specific Impulse (Note 1)	sec	423.5	± 3.4
Before PU Valve Cutback (Note 2)	sec	421.6	± 2.8
After PU Valve Cutback (Note 3)	sec	427.0	± 3.6
Engine Total Impulse (Note 1)	1bf-sec	96.986×10^6	$\pm 1.4 \times 10^6$
PU Valve Cutback Time from ESC	sec	280	± 45
Start Impulse (Note 4)	1bf-sec	173,860	$\pm 30,000$
Cutoff Impulse (Note 5)	1bf-sec	51,311	$\pm 9,000$
Time from 90% Thrust to ECC*	sec	446.97	± 20
Total Depletion Burntime (ESC to Depletion)	sec	449.97	± 20
Loaded Propellants (Note 6)	(LOX) 1bm	193,273	$\pm 2,165$
	(LH2) 1bm	37,636	± 419
	(Total) 1bm	230,909	$\pm 2,205$
Engine Propellant			
Consumption (90% Thrust to ECC*) (Note 1)	(LOX) 1bm	192,404	$\pm 2,157$
	(LH2) 1bm	36,622	± 405
	(Total) 1bm	229,026	$\pm 2,195$

*As used in this table, ECC refers to propellant depletion engine cutoff.
 No guidance cutoff commands are included.

TABLE AP 5-1 (Sheet 2 of 2)
PREDICTED PERFORMANCE PARAMETERS, S-IVB-206 PROPULSION SYSTEM

NOTES:

1. Averaged or determined for time period of 90 percent thrust buildup to Engine Cutoff Command (ECC). Does not include ullage rocket operation.
2. During period when PU valve is against the LOX rich stop.
3. During period 5 sec after PU valve cutback until Engine Cutoff Command received by the engine.
4. Determined for time period of Engine Start Command to 90 percent thrust buildup.
5. Determined for time period of Engine Cutoff Command as monitored on the J-2 engine until thrust decay to zero.
6. Included is 116 lbm LH2 and 330 lbm LOX for thrust buildup propellants.

TABLE AP 5-2
 J-2 ENGINE TAG VALUES (ENGINE 2046)

PARAMETER	UNITS	PU VALVE POSITION		
		32.6 Deg	Null	-27.8 Deg
Thrust	lbf	228,315	205,315	175,815
Engine mixture ratio	--	5.536	4.954	4.383
Specific impulse	sec	422.80	427.48	430.00
Total propellant flowrate	lbm/sec	540.00	480.29	408.87
LH2 flowrate	lbm/sec	457.38	399.62	332.91
LOX flowrate	lbm/sec	82.62	80.67	75.96

TABLE AP 5-3
PRESSURIZATION LIMITS AND PRESSURANT FLOWRATES

	UNITS	LH2	LOX
<u>Pressurization Limits (Nominal)</u>			
Initial pressure (prepressurization)	psia	34.0	42.4
Lower limit	psia	27.0	36.8
Upper limit	psia	29.0	38.8
Vent limit	psia	38.5	40.7
<u>Pressurant Flowrates (Nominal)</u>			
LH2 Side:			
Undercontrol	lbm/sec	0.37	
Overcontrol	lbm/sec	0.66	
Step (ESC +299 sec)	lbm/sec	1.18	
LOX Side:			
By-pass	lbm/sec		0.20
Primary	lbm/sec		0.075
Secondary	lbm/sec		0.135

TABLE AP 5-4 (Sheet 1 of 7)
 PREDICTED S-IVB-206 PROPULSION SYSTEM PERFORMANCE
 COMPUTER PROGRAM AA89

	TIME	WDOTSUBD	WDOTSURF	WDOTSURT	DEL								
1	TSUBF	TPSUBD	TPSUBF	TPSUBT	DEL	1	1.000	11.927	52.733	64.454	0.000		
2	FSUB	FPD	FPD	FSUBT	FSUBT	2	31916.13	42.909	33.564	199.284	465.697		
3	ENGINE ISP	TOP	TOP	VSUBD	VSUBD	3	0.724	43.440	33.000	2725.978	8591.671		
4	CSURFV	RHSURD	RHSURF	WOPU USARLF	WFPU USABLE	4	493.644	164.700	37.552	192529.926	36385.645		
5	PCF	WDOTFRD	WDOTFRD	WO USABLE	WF USABLE	5	1.721	70.778	4.372	192529.926	36385.645		
6	IPS	WDOTFRD	WDOTFRD	WO IN TANK	WF IN TANK	6	100.000	0.000	0.000	192529.926	36385.645		
7	FDS	TITIME	TITIME	FUEL OVB	FUEL OVB	7	244.932	0.209	0.380	192876.898	37560.400		
8	ESURAU	TITOLX	TITIME	WDOTOVB	WDOTOVB	8	14817.432	5.327	40.000	193243.898	37608.400		
9	WSURD FRDR	WDOT	WDOT	WDOTOVB	WDOTOVB	9	0.000	0.000	150.600	29.102	26.991		
10	WSURF	TITIME	TITIME	WDOT	WDOT	10	0.000	0.000	0.000	0.000	0.000		
11	GCMR	WDOTGG	WDOTGG	DRAG	WFSUB	11	329.473	35.327	190.600	0.000	0.000		
12	ASUR	WDOTGG	WDOTGG	DRAG	WFSUB	12	0.000	0.000	2.242	0.000	0.000		
13						13	0.000	0.000	0.608	0.000	29608.297		553.414
1	0.000	0.000	0.000	0.000	0.000	1	1.800	73.952	53.605	127.358	0.000		
2	0.000	44.000	33.000	199.324	464.061	2	61275.64	42.225	33.477	199.274	465.617		
3	0.000	44.000	33.000	2725.486	8640.049	3	1.385	43.370	33.000	2724.975	8589.250		
4	0.000	164.700	37.550	192559.000	36412.924	4	4.81131	164.701	37.552	192522.594	36375.063		
5	1.721	70.779	4.372	192559.000	36412.924	5	1.721	70.778	4.372	192522.594	36375.063		
6	0.000	0.000	0.000	192687.000	36577.924	6	0.380	0.380	0.380	192906.000	37588.000		
7	0.000	0.000	0.000	192906.000	37587.924	7	0.000	0.000	0.000	193273.000	37636.000		
8	0.000	5.000	40.000	192906.000	37587.924	8	0.000	0.000	0.000	150.152	0.000		
9	0.000	30.000	150.152	0.000	0.000	9	0.000	0.000	0.000	0.000	0.000		
10	-87.914	0.000	0.000	0.000	0.000	10	0.000	0.000	150.684	36.441	37.592		
11	329.000	35.000	190.600	0.000	0.000	11	329.473	35.327	190.600	0.000	0.000		
12	0.000	0.000	0.000	0.000	0.000	12	0.000	0.000	2.242	0.000	0.000		
13	0.000	0.000	0.000	0.000	0.000	13	0.000	0.000	0.608	0.000	29608.297		553.414
1	0.000	0.000	0.000	0.000	0.000	1	2.000	150.896	54.735	295.731	0.000		
2	0.000	43.930	33.000	199.324	465.898	2	93610.54	41.628	33.384	199.243	465.536		
3	0.000	43.930	33.000	2725.486	8597.815	3	2.758	43.300	33.000	2724.688	8586.780		
4	0.000	164.700	37.550	192559.000	36412.924	4	4.55335	164.701	37.553	192500.119	36364.269		
5	1.721	70.779	4.372	192559.000	36412.924	5	1.721	70.778	4.372	192500.119	36364.269		
6	0.000	0.000	0.000	192687.000	36577.924	6	0.380	0.380	0.380	192906.000	37588.000		
7	0.000	0.000	0.000	192906.000	37587.924	7	0.000	0.000	0.000	193273.000	37636.000		
8	0.000	5.000	40.000	192906.000	37587.924	8	0.000	0.000	0.000	150.152	0.000		
9	0.000	30.000	150.152	0.000	0.000	9	0.000	0.000	0.000	0.000	0.000		
10	8.942	0.000	0.000	0.000	0.000	10	0.000	0.000	150.740	36.411	37.592		
11	329.940	35.000	190.600	0.000	0.000	11	329.473	35.327	190.600	0.000	0.000		
12	0.000	0.000	0.000	0.000	0.000	12	0.000	0.000	2.242	0.000	0.000		
13	0.000	0.000	0.000	0.000	0.000	13	0.000	0.000	0.608	0.000	29608.297		553.414
1	0.000	0.000	0.000	0.000	0.000	1	2.000	150.896	54.735	295.731	0.000		
2	0.000	43.930	33.000	199.324	465.898	2	93610.54	41.628	33.384	199.243	465.536		
3	0.000	43.930	33.000	2725.486	8597.815	3	2.758	43.300	33.000	2724.688	8586.780		
4	0.000	164.700	37.550	192559.000	36412.924	4	4.55335	164.701	37.553	192500.119	36364.269		
5	1.721	70.779	4.372	192559.000	36412.924	5	1.721	70.778	4.372	192500.119	36364.269		
6	0.000	0.000	0.000	192687.000	36577.924	6	0.380	0.380	0.380	192906.000	37588.000		
7	0.000	0.000	0.000	192906.000	37587.924	7	0.000	0.000	0.000	193273.000	37636.000		
8	0.000	5.000	40.000	192906.000	37587.924	8	0.000	0.000	0.000	150.152	0.000		
9	0.000	30.000	150.152	0.000	0.000	9	0.000	0.000	0.000	0.000	0.000		
10	8.942	0.000	0.000	0.000	0.000	10	0.000	0.000	150.740	36.411	37.592		
11	329.940	35.000	190.600	0.000	0.000	11	329.473	35.327	190.600	0.000	0.000		
12	0.000	0.000	0.000	0.000	0.000	12	0.000	0.000	2.242	0.000	0.000		
13	0.000	0.000	0.000	0.000	0.000	13	0.000	0.000	0.608	0.000	29608.297		553.414
1	0.000	0.000	0.000	0.000	0.000	1	2.000	150.896	54.735	295.731	0.000		
2	0.000	43.930	33.000	199.324	465.898	2	93610.54	41.628	33.384	199.243	465.536		
3	0.000	43.930	33.000	2725.486	8597.815	3	2.758	43.300	33.000	2724.688	8586.780		
4	0.000	164.700	37.550	192559.000	36412.924	4	4.55335	164.701	37.553	192500.119	36364.269		
5	1.721	70.779	4.372	192559.000	36412.924	5	1.721	70.778	4.372	192500.119	36364.269		
6	0.000	0.000	0.000	192687.000	36577.924	6	0.380	0.380	0.380	192906.000	37588.000		
7	0.000	0.000	0.000	192906.000	37587.924	7	0.000	0.000	0.000	193273.000	37636.000		
8	0.000	5.000	40.000	192906.000	37587.924	8	0.000	0.000	0.000	150.152	0.000		
9	0.000	30.000	150.152	0.000	0.000	9	0.000	0.000	0.000	0.000	0.000		
10	8.942	0.000	0.000	0.000	0.000	10	0.000	0.000	150.740	36.411	37.592		
11	329.940	35.000	190.600	0.000	0.000	11	329.473	35.327	190.600	0.000	0.000		
12	0.000	0.000	0.000	0.000	0.000	12	0.000	0.000	2.242	0.000	0.000		
13	0.000	0.000	0.000	0.000	0.000	13	0.000	0.000	0.608	0.000	29608.297		553.414
1	0.000	0.000	0.000	0.000	0.000	1	2.000	150.896	54.735	295.731	0.000		
2	0.000	43.930	33.000	199.324	465.898	2	93610.54	41.628	33.384	199.243	465.536		
3	0.000	43.930	33.000	2725.486	8597.815	3	2.758	43.300	33.000	2724.688	8586.780		
4	0.000	164.700	37.550	192559.000	36412.924	4	4.55335	164.701	37.553	192500.119	36364.269		
5	1.721	70.779	4.372	192559.000	36412.924	5	1.721	70.778	4.372	192500.119	36364.269		
6	0.000	0.000	0.000	192687.000	36577.924	6	0.380	0.380	0.380	192906.000	37588.000		
7	0.000	0.000	0.000	192906.000	37587.924	7	0.000	0.000	0.000	193273.000	37636.000		
8	0.000	5.000	40.000	192906.000	37587.924	8	0.000	0.000	0.000	150.152	0.000		
9	0.000	30.000	150.152	0.000	0.000	9	0.000	0.000	0.000	0.000	0.000		
10	8.942	0.000	0.000	0.000	0.000	10	0.000	0.000	150.740	36.411	37.592		
11	329.940	35.000	190.600	0.000	0.000	11	329.473	35.327	190.600	0.000	0.000		
12	0.000	0.000	0.000	0.000	0.000	12	0.000	0.000	2.242	0.000	0.000		
13	0.000	0.000	0.000	0.000	0.000	13	0.000	0.000	0.608	0.000	29608.297		553.414

TABLE AP 5-4 (Sheet 2 of 7)
 PREDICTED S-IVB-206 PROPULSION SYSTEM PERFORMANCE
 COMPUTER PROGRAM AA89

1	10.000	460.422	82.767	543.580	32.600	1	55.000	461.504	82.889	544.393	32.600
2	230045.99	36.456	33.650	194.869	440.716	2	230047.63	40.816	291.320	174.774	432.601
3	5.568	40.500	13.000	2679.940	8441.514	3	5.568	42.173	28.688	2387.748	7594.225
4	423.197	164.703	37.563	189331.479	35731.223	4	422.650	164.716	37.621	188607.748	32020.916
5	1.748	70.776	4.371	189331.479	35731.223	5	1.749	70.760	4.366	188607.748	32020.916
6	770.473	0.358	0.000	189459.479	35896.223	6	770.438	0.358	0.000	188735.748	32185.915
7	8617.442	0.256	0.380	189675.299	36000.138	7	8618.507	0.392	0.380	188911.115	33156.714
8	26531.320	7.278	40.000	19042.295	36948.138	8	26644.700	22.695	40.000	169298.115	33204.714
9	0.000	37.488	153.800	3228.217	684.062	9	0.000	48.598	170.899	23956.285	4410.385
10	8.964	2.488	0.000	0.000	0.000	10	7.498	18.598	0.000	0.000	0.000
11	327.722	39.766	193.800	0.000	0.000	11	312.304	71.293	210.899	0.000	0.000
12	0.970	3.456	3.562	0.000	292218.430	12	0.967	3.458	3.575	0.000	267730.828
13	0.877	3.800	3.800	0.000	165616.703	13	0.859	3.460	20.900	0.000	11999811.500
1	15.000	460.570	82.808	543.337	32.600	1	60.000	461.760	82.923	544.683	32.600
2	229018.44	36.456	33.549	197.111	457.549	2	230175.88	40.816	291.320	174.774	429.462
3	5.561	39.733	12.900	2647.435	8347.013	3	5.569	42.835	28.408	2354.792	7499.621
4	423.161	164.704	37.569	187028.533	35319.028	4	422.587	164.718	37.628	186300.023	31608.158
5	1.748	70.774	4.371	187028.533	35319.028	5	1.749	70.758	4.366	186300.023	31608.158
6	770.473	0.358	0.000	187156.531	35484.027	6	770.579	0.358	0.000	186428.023	31773.158
7	8617.442	0.256	0.380	187370.076	36484.264	7	8619.349	0.400	0.380	186621.115	32740.273
8	26547.143	8.625	40.000	187737.076	36532.264	8	26682.769	24.676	40.000	166988.115	32788.272
9	0.000	34.278	155.700	5531.645	1098.036	9	0.000	50.388	172.799	26264.496	4824.927
10	8.801	4.278	0.000	0.000	0.000	10	7.334	20.388	0.000	0.000	0.000
11	324.375	39.766	193.800	0.000	0.000	11	310.323	75.064	212.799	0.000	0.000
12	0.968	3.454	3.564	0.000	288497.540	12	0.967	3.460	3.577	0.000	265066.347
13	0.794	3.800	3.800	0.000	2806533.063	13	0.869	3.460	22.800	0.000	13150467.000
1	20.000	460.237	82.808	543.045	32.600	1	65.000	461.577	82.930	544.507	32.600
2	229045.65	36.456	33.549	197.111	457.549	2	230084.98	40.816	291.320	174.774	426.361
3	5.558	38.967	12.650	2614.949	8252.662	3	5.566	42.359	28.138	2322.356	7404.377
4	423.142	164.706	37.576	184727.051	34966.745	4	422.556	164.719	37.634	183991.684	31195.280
5	1.748	70.777	4.371	184727.051	34966.745	5	1.749	70.757	4.365	183991.684	31195.280
6	769.686	0.358	0.000	184855.051	35071.745	6	770.294	0.358	0.000	184119.684	31366.280
7	8617.442	0.256	0.380	185064.324	36066.961	7	8619.349	0.400	0.380	184314.302	32323.316
8	26552.864	10.116	40.000	185433.324	36116.301	8	26691.529	26.162	40.000	166477.696	32371.714
9	0.000	36.068	157.600	7833.677	1512.099	9	0.000	52.178	174.699	28573.324	5239.590
10	8.639	6.068	0.000	0.000	0.000	10	7.170	22.178	0.000	0.000	0.000
11	324.884	46.184	197.600	0.000	0.000	11	308.837	78.340	214.699	0.000	0.000
12	0.968	3.452	3.564	0.000	286777.828	12	0.967	3.458	3.578	0.000	262270.278
13	0.801	3.800	3.800	0.000	3955791.563	13	0.877	3.460	24.700	0.000	14301294.875
1	25.000	459.947	82.777	542.725	32.600	1	70.000	461.100	82.923	544.073	32.600
2	229045.75	36.456	32.811	197.111	451.328	2	229074.39	39.075	291.320	174.774	423.170
3	5.554	38.200	12.187	2582.483	8150.590	3	5.562	42.100	27.844	2289.105	7330.005
4	423.126	164.707	37.587	182427.023	34494.525	4	422.546	164.721	37.641	181685.430	30782.426
5	1.748	70.771	4.371	182427.023	34494.525	5	1.749	70.755	4.365	181685.430	30782.426
6	769.686	0.358	0.000	182555.023	34659.525	6	769.659	0.358	0.000	181813.430	30947.426
7	8617.442	0.256	0.380	182764.027	35652.402	7	8618.507	0.400	0.380	182008.052	31907.411
8	26552.767	11.730	40.000	183131.027	35700.402	8	26691.529	27.662	40.000	162368.967	31955.771
9	0.000	37.858	159.500	10134.113	1926.098	9	0.000	53.968	175.599	30980.064	5654.229
10	8.477	7.858	0.000	0.000	0.000	10	7.397	23.968	0.000	0.000	0.000
11	323.270	49.888	199.500	0.000	0.000	11	307.997	81.570	216.599	0.000	0.000
12	0.968	3.452	3.564	0.000	284059.430	12	0.966	3.455	3.578	0.000	259552.137
13	0.806	3.800	3.800	0.000	5104370.563	13	0.886	3.460	26.600	0.000	15451190.000
1	30.000	460.210	82.769	542.978	32.600	1	75.000	461.314	82.945	544.229	32.600
2	229074.58	36.456	31.975	197.111	448.220	2	229045.68	39.627	291.320	174.774	420.037
3	5.560	38.967	12.513	2595.015	8064.961	3	5.567	42.359	27.844	2295.064	7235.311
4	423.144	164.709	37.589	180127.063	34082.432	4	422.493	164.722	37.647	180799.830	31369.530
5	1.748	70.769	4.369	180127.063	34082.432	5	1.749	70.753	4.364	180799.830	31369.530
6	769.686	0.358	0.000	180255.063	34247.432	6	769.650	0.358	0.000	180907.830	30534.529
7	8617.442	0.256	0.380	180461.797	35236.631	7	8617.100	0.411	0.380	181094.052	31400.529
8	26567.288	13.411	40.000	180828.797	35284.631	8	26709.090	29.152	40.000	167661.792	31538.589
9	0.000	39.648	161.399	12434.555	2339.969	9	0.000	55.758	178.499	31361.148	6668.911
10	8.315	9.648	0.000	0.000	0.000	10	6.844	25.758	0.000	0.000	0.000
11	321.598	53.359	201.399	0.000	0.000	11	305.646	85.110	218.499	0.000	0.000
12	0.968	3.451	3.565	0.000	281341.426	12	0.966	3.456	3.579	0.000	256805.648
13	0.816	3.800	3.800	0.000	6252729.938	13	0.895	3.460	26.600	0.000	16602737.125
1	35.000	460.477	82.768	543.239	32.600	1	80.000	461.527	82.943	544.491	32.600
2	229074.42	37.466	31.198	197.111	445.112	2	230016.29	40.178	27.000	186.232	416.894
3	5.563	38.967	12.513	2595.015	8064.961	3	5.563	42.767	27.888	2274.486	7120.755
4	422.956	164.710	37.595	177825.791	33670.367	4	422.443	164.724	37.654	157073.162	29956.530
5	1.748	70.767	4.368	177825.791	33670.367	5	1.749	70.751	4.364	157073.162	29956.530
6	769.686	0.358	0.000	177953.791	33835.367	6	770.040	0.358	0.000	157201.162	30121.530
7	8617.442	0.256	0.380	178150.256	34820.367	7	8617.721	0.415	0.380	157395.148	31079.312
8	26584.399	15.160	40.000	178525.256	34868.888	8	26727.666	31.418	40.000	157521.148	31121.912
9	0.000	61.439	163.299	14736.307	2753.103	9	0.000	57.548	180.399	35493.303	6463.680
10	8.153	11.439	0.000	0.000	0.000	10	6.881	27.548	0.000	0.000	0.000
11	319.840	56.558	203.299	0.000	0.000	11	303.580	88.966	220.399	0.000	0.000
12	0.968	3.452	3.565	0.000	278622.141	12	0.966	3.458	3.582	0.000	254102.081
13	0.825	3.800	3.800	0.000	7401493.375	13	0.905	3.460	30.400	0.000	17750636.250
1	40.000	460.732	82.793	543.525	32.600	1	85.000	461.791	82.982	544.722	32.600
2	229074.22	36.142	30.477	197.111	441.995	2	230084.98	40.798	27.626	186.610	413.749
3	5.565	38.967	12.500	2495.020	7877.340	3	5.564	42.767	27.000	2191.901	7026.000
4	422.864	164.712	37.602	175523.213	33258.248	4	422.393	164.725	37.660	154765.430	29543.457
5	1.748	70.765	4.368	175523.213	33258.248	5	1.749	70.749	4.363	154765.430	29543.457
6	769.686	0.358	0.000	175651.213	33423.248	6	770.229	0.358	0.000	154993.430	29784.457
7	8617.442	0.256	0.380	175853.404	34405.090	7	8618.343	0.419	0.380	155075.139	30657.144
8	26616.464	16.976	40.000	176225.404	34453.090	8	26735.042	33.502	40.000	155442.139	30705.144
9	0.000	43.228	165.199	177039.367	3167.709	9	0.000	59.338	182.298	37801.521	6898.564
10	7.989	13.228	0.000	0.000	0.000	10	6.517	29.338	0.000	0.000	0.000
11	318.073	60.294	205.199	0.000	0.000	11	301.446	92.840	222.298	0.000	0.000
12	0.968	3.454	3.569	0.000	275901.492	12	0.966	3.459	3.582	0.000	251375.281
13	0.833	3.800	3.800	0.000	8550398.875	13	0.915	3.460			

TABLE AP 5-4 (Sheet 3 of 7)
 PREDICTED S-IVB-206 PROPULSION SYSTEM PERFORMANCE
 COMPUTER PROGRAM AA89

1	100.000	461.068	82.968	544.036	32.600	1	145.000	461.541	82.867	544.408	32.600
2	229744.91	39.030	26.778	160.032	404.309	2	229734.62	40.018	27.460	147.946	375.881
3	5.557	41.100	26.168	2094.120	6741.627	3	5.570	42.250	26.887	1801.011	5883.516
4	422.334	164.730	37.680	147843.930	28304.099	4	421.990	164.761	37.734	127081.908	24583.741
5	1.749	70.744	4.362	147843.934	28304.099	5	1.749	70.718	4.360	127081.908	24583.741
6	769.535	0.358	0.000	147843.930	28469.090	6	769.910	0.358	0.000	127090.908	24748.741
7	8614.313	0.310	0.380	148146.811	29466.715	7	8614.232	0.452	0.670	127364.302	25553.160
8	26749.539	38.361	40.000	148513.811	29454.715	8	26808.124	55.826	40.000	127731.302	25701.160
9	0.000	64.708	187.998	44724.440	8143.285	9	0.000	80.818	211.333	65490.880	11873.505
10	6.028	34.406	0.000	0.000	0.000	10	4.567	50.818	0.000	0.000	0.000
11	296.637	103.069	277.998	0.000	0.000	11	279.171	136.644	251.333	0.000	0.000
12	0.964	3.454	3.583	0.000	243196.525	12	0.962	3.455	3.590	0.000	218660.461
13	0.945		38.000		22350473.250	13	1.051		32690833.750		
1	105.000	461.368	82.984	544.352	32.600	1	150.000	461.733	82.911	544.645	32.600
2	229877.26	39.770	26.527	158.561	401.159	2	229830.32	40.518	27.841	146.581	372.712
3	5.560	41.800	25.920	2061.557	6646.706	3	5.569	42.775	27.270	1768.422	5787.693
4	422.276	164.733	37.686	145538.207	27890.992	4	421.982	164.765	37.740	124774.187	24169.634
5	1.749	70.742	4.362	145538.207	27890.992	5	1.749	70.715	4.360	124774.187	24169.634
6	769.531	0.358	0.000	145666.207	28055.992	6	769.209	0.358	0.000	124902.187	24334.634
7	8616.070	0.473	0.380	145838.813	28989.930	7	8615.217	0.454	0.670	125554.303	25235.357
8	26761.191	49.457	40.000	146205.813	29037.930	8	26816.889	58.092	40.000	125421.303	25283.357
9	0.000	66.498	189.898	47030.688	8558.170	9	0.000	82.608	214.683	67799.089	12287.958
10	5.866	34.498	0.000	0.000	0.000	10	4.406	52.608	0.000	0.000	0.000
11	294.541	104.954	229.898	0.000	0.000	11	274.905	140.699	254.683	0.000	0.000
12	0.964	3.454	3.584	0.000	240471.742	12	0.962	3.456	3.591	0.000	215932.660
13	0.956		39.900		23499584.000	13	1.064		64.685		33839738.000
1	110.000	461.634	83.001	544.635	32.600	1	155.000	461.926	82.955	544.881	32.600
2	229968.52	40.600	26.494	157.122	398.006	2	229925.40	41.018	28.208	145.415	369.542
3	5.560	41.800	25.720	2028.987	6551.709	3	5.568	43.300	27.640	1735.817	5691.832
4	422.244	164.737	37.692	143231.145	27477.811	4	421.974	164.766	37.764	122465.500	23755.310
5	1.749	70.739	4.361	143231.145	27477.811	5	1.750	70.712	4.360	122465.500	23755.310
6	769.880	0.358	0.000	143359.145	27642.811	6	769.506	0.358	0.000	122593.500	23920.310
7	8616.964	0.380	0.380	143529.145	28573.811	7	8616.194	0.455	0.670	122743.339	24817.335
8	26777.353	42.630	40.000	143896.473	28621.061	8	26825.627	64.363	40.000	123110.339	24865.335
9	0.000	68.288	191.798	49338.238	8973.139	9	0.000	84.398	218.033	70108.263	12702.630
10	5.703	38.288	0.000	0.000	0.000	10	4.245	54.398	0.000	0.000	0.000
11	297.368	110.918	231.798	0.000	0.000	11	274.634	144.761	258.033	0.000	0.000
12	0.964	3.454	3.585	0.000	237745.533	12	0.962	3.457	3.593	0.000	213203.674
13	0.967		41.800		26449180.000	13	1.078		68.035		34989115.500
1	115.000	461.899	83.018	544.918	32.600	1	160.000	461.765	82.978	544.743	32.600
2	230064.78	41.096	26.129	155.684	394.853	2	229875.77	40.680	28.555	144.149	366.371
3	5.562	42.760	25.320	1996.408	6456.548	3	5.565	42.990	27.990	1703.208	5595.950
4	422.201	164.740	37.699	149922.750	27064.546	4	421.989	164.772	37.752	120156.803	23340.826
5	1.749	70.736	4.361	149922.750	27064.546	5	1.749	70.709	4.360	120156.803	23340.826
6	770.069	0.358	0.000	141090.750	27229.546	6	769.300	0.358	0.000	120284.803	23505.826
7	8617.859	0.380	0.380	141218.801	28112.007	7	8615.014	0.344	0.670	120432.363	24399.152
8	26781.878	44.821	40.000	141585.801	28204.107	8	26827.735	62.133	40.000	120799.363	24447.152
9	0.000	70.078	193.698	51647.121	9388.193	9	0.000	86.188	221.383	72417.448	13117.463
10	5.540	40.078	0.000	0.000	0.000	10	4.085	56.188	0.000	0.000	0.000
11	297.177	114.899	233.698	0.000	0.000	11	272.863	148.371	267.882	0.000	0.000
12	0.964	3.454	3.586	0.000	235017.906	12	0.962	3.457	3.593	0.000	210474.514
13	0.979		43.700		25799256.750	13	1.092		71.385		36138579.000
1	120.000	461.672	83.019	544.681	32.600	1	165.000	461.591	83.293	544.884	32.600
2	229960.27	40.580	25.917	154.266	391.698	2	230050.49	40.335	28.697	142.883	363.200
3	5.562	42.760	25.320	1996.408	6456.548	3	5.562	42.679	28.125	1670.608	5500.213
4	422.192	164.744	37.704	138614.324	26651.262	4	422.201	164.775	37.758	117848.827	22926.210
5	1.749	70.733	4.360	138614.324	26651.262	5	1.749	70.706	4.360	117848.827	22926.210
6	769.752	0.358	0.000	138742.324	26816.262	6	770.152	0.358	0.000	117976.827	23091.210
7	8616.662	0.322	0.380	139094.708	27739.125	7	8617.412	0.346	0.380	118122.110	23980.836
8	26785.653	44.685	40.000	139275.098	28837.135	8	26836.819	63.850	40.000	118489.110	24228.836
9	0.000	71.868	195.598	53956.033	9883.225	9	0.000	87.978	224.298	74725.911	13532.865
10	5.376	41.868	0.000	0.000	0.000	10	4.925	57.978	0.000	0.000	0.000
11	298.512	118.353	235.598	0.000	0.000	11	271.836	151.836	267.997	0.000	0.000
12	0.964	3.454	3.586	0.000	232290.232	12	0.962	3.458	3.595	0.000	207745.945
13	0.997		45.600		26949286.500	13	1.107		74.300		37288176.500
1	125.000	461.524	82.713	544.237	32.600	1	170.000	461.469	83.284	544.753	32.600
2	229958.82	40.063	25.937	153.001	388.539	2	229989.48	39.994	27.505	141.618	360.033
3	5.580	42.760	25.353	1931.254	6268.308	3	5.541	42.369	27.307	1638.015	5404.724
4	421.983	164.747	37.710	136706.824	26238.019	4	422.190	164.779	37.764	115541.636	22511.562
5	1.750	70.730	4.360	136706.824	26238.019	5	1.749	70.703	4.360	115541.636	22511.562
6	768.614	0.358	0.000	136434.824	26403.019	6	769.943	0.358	0.000	115669.636	22676.562
7	8617.479	0.375	0.670	136588.320	27322.024	7	8616.798	0.348	0.380	115812.443	23562.487
8	26781.079	44.107	40.000	136965.320	27370.206	8	26836.365	65.659	40.000	116179.443	23610.487
9	0.000	73.658	197.933	56764.021	10217.862	9	0.000	89.768	226.197	77033.589	13949.314
10	5.213	43.658	0.000	0.000	0.000	10	3.766	59.768	0.000	0.000	0.000
11	286.895	121.760	237.933	0.000	0.000	11	266.401	150.836	266.997	0.000	0.000
12	0.963	3.454	3.585	0.000	229563.523	12	0.962	3.457	3.595	0.000	205018.120
13	1.000		47.935		28098532.750	13	1.122		76.200		38438263.500
1	130.000	461.323	82.742	544.065	32.600	1	175.000	461.347	83.267	544.614	32.600
2	229594.38	39.539	26.318	151.737	385.377	2	229929.46	39.657	28.212	140.353	356.865
3	5.575	41.788	25.737	1898.691	6170.671	3	5.541	42.059	27.750	1605.428	5309.235
4	421.908	164.685	37.716	134000.143	25824.715	4	422.186	164.782	37.773	113235.054	22096.980
5	1.749	70.727	4.360	134000.143	25824.715	5	1.749	70.700	4.359	113235.054	22096.980
6	768.444	0.358	0.000	134128.143	25989.715	6	769.749	0.358	0.000	113363.054	22261.980
7	8611.926	0.372	0.670	134289.363	26905.210	7	8616.184	0.351	0.380	113503.784	23144.204
8	26784.534	49.732	40.000	134656.363	26953.210	8	26837.536	67.343	40.000	113870.784	23192.204
9	0.000	75.448	201.283	58571.188	10631.565	9	0.000	91.558	228.007	79360.657	14365.696
10	5.051	45.448	0.000	0.000	0.000	10	3.606	61.558	0.000	0.000	0.000
11	285.265	125.180	241.283	0.000	0.000	11	267.453				

TABLE AP 5-4 (Sheet 4 of 7)
 PREDICTED S-IVB-206 PROPULSION SYSTEM PERFORMANCE
 COMPUTER PROGRAM AA89

1	190.000	461.367	83.236	544.603	32.600	1	235.000	461.415	83.126	544.541	32.600
2	229902.11	39.555	27.734	136.559	347.359	2	229821.20	39.574	26.319	125.157	318.894
3	5.543	42.045	27.187	1507.486	5022.771	3	5.551	42.385	25.827	1213.952	4164.674
4	422.146	164.793	37.788	106317.729	20853.677	4	422.046	164.835	37.887	85547.875	17125.908
5	1.749	70.691	4.358	106317.729	20853.677	5	1.749	70.669	4.353	85547.875	17125.908
6	769.652	0.358	0.000	106445.729	21018.676	6	769.308	0.358	0.000	85675.875	17290.908
7	8616.610	0.462	0.380	106579.635	21889.803	7	8614.789	0.355	0.380	85789.285	18128.763
8	26842.234	73.239	40.000	106944.535	21937.003	8	26855.290	91.000	40.000	86156.286	18176.763
9	0.000	96.928	233.797	86259.437	15614.397	9	0.000	113.038	250.896	107033.976	19358.337
10	3.129	66.928	0.000	0.000	0.000	10	1.682	83.038	0.000	0.000	0.000
11	261.757	170.166	273.797	0.000	0.000	11	243.988	204.045	290.896	0.000	0.000
12	0.962	3.456	0.000	0.000	194112.008	12	0.962	3.456	3.592	0.000	169561.000
13	1.184	0.000	85.799	0.000	43036065.000	13	1.355	0.000	100.899	0.000	53384353.000
1	195.000	461.538	83.236	544.773	32.600	1	240.000	461.335	83.108	544.443	32.600
2	229960.66	39.979	27.541	135.293	344.189	2	229777.71	39.346	26.175	123.849	315.721
3	5.545	42.500	27.000	1475.085	4927.262	3	5.552	42.192	25.691	1181.310	4069.348
4	422.122	164.796	37.794	104010.928	20439.293	4	422.042	164.840	37.900	83241.462	16712.109
5	1.749	70.688	4.358	104010.928	20439.293	5	1.749	70.668	4.352	83241.462	16712.109
6	769.811	0.358	0.000	104138.928	20604.293	6	769.168	0.358	0.000	83369.462	16877.109
7	8617.144	0.462	0.380	104270.857	21471.721	7	8614.340	0.355	0.380	83480.598	17711.271
8	26846.804	75.550	40.000	104637.557	21519.721	8	26854.779	92.784	40.000	83841.598	18299.271
9	0.000	98.718	235.497	88566.725	16030.579	9	0.000	114.828	252.796	109340.574	19773.929
10	2.949	68.718	0.000	0.000	0.000	10	1.521	84.828	0.000	0.000	0.000
11	259.445	174.268	275.497	0.000	0.000	11	242.212	207.611	292.796	0.000	0.000
12	0.962	3.457	3.594	0.000	191385.277	12	0.962	3.455	3.592	0.000	166934.000
13	1.202	0.000	85.699	0.000	44185709.500	13	1.377	0.000	102.799	0.000	54533337.500
1	200.000	461.710	83.233	544.942	32.600	1	245.000	461.255	83.090	544.345	32.600
2	230019.08	40.402	27.348	134.027	341.019	2	229734.21	39.105	26.031	122.623	312.558
3	5.547	42.445	26.812	1442.469	4831.739	3	5.551	42.000	25.655	1148.672	3974.016
4	422.098	164.800	37.800	101703.270	20204.917	4	422.038	164.845	37.912	80935.449	16299.400
5	1.749	70.685	4.357	101703.270	20204.917	5	1.749	70.666	4.352	80935.449	16299.400
6	769.970	0.358	0.000	101831.270	20189.917	6	769.029	0.358	0.000	81063.449	16663.400
7	8617.678	0.463	0.380	101966.622	21053.647	7	8613.891	0.355	0.380	81172.310	17293.869
8	26851.556	77.863	40.000	102321.647	21161.647	8	26854.270	90.659	40.000	81539.310	17341.869
9	0.000	100.508	237.597	90874.869	16446.753	9	0.000	116.618	254.656	111647.072	20189.400
10	2.809	70.508	0.000	0.000	0.000	10	1.746	86.618	0.000	0.000	0.000
11	257.132	178.371	277.597	0.000	0.000	11	240.436	211.176	294.696	0.000	0.000
12	0.962	3.458	3.595	0.000	188657.268	12	0.962	3.454	3.591	0.000	164109.178
13	1.219	0.000	87.599	0.000	45335646.000	13	1.400	0.000	104.699	0.000	55682105.000
1	205.000	461.878	83.229	545.108	32.600	1	250.000	461.674	83.088	544.562	32.600
2	230075.24	40.824	27.175	132.761	337.859	2	229812.17	39.561	25.888	121.355	309.394
3	5.549	43.409	26.464	1409.844	4736.494	3	5.554	42.500	25.418	1116.027	3878.668
4	422.073	164.805	37.812	99394.763	19610.558	4	422.013	164.850	37.925	78629.022	15884.737
5	1.749	70.681	4.357	99394.763	19610.558	5	1.749	70.665	4.351	78629.022	15884.737
6	770.121	0.358	0.000	99522.763	19775.558	6	769.243	0.358	0.000	78757.022	16049.736
7	8618.181	0.463	0.380	99649.837	20635.590	7	8615.372	0.462	0.380	78863.607	16876.514
8	26856.820	80.178	40.000	100166.837	20683.590	8	26859.326	96.810	40.000	79230.607	16924.514
9	0.000	102.298	239.497	93183.368	16862.810	9	0.000	118.408	256.566	113952.984	20604.000
10	2.648	72.298	0.000	0.000	0.000	10	1.198	88.408	0.000	0.000	0.000
11	254.818	182.475	279.497	0.000	0.000	11	238.176	215.226	296.596	0.000	0.000
12	0.962	3.459	3.595	0.000	185928.426	12	0.962	3.456	3.591	0.000	161383.121
13	1.237	0.000	89.499	0.000	46485868.500	13	1.424	0.000	106.599	0.000	56830985.500
1	210.000	461.815	83.216	545.930	32.600	1	255.000	461.654	83.084	544.738	32.600
2	230038.67	40.727	27.033	131.494	334.697	2	229874.00	40.017	25.743	120.088	306.229
3	5.550	43.346	26.500	1377.211	4641.268	3	5.556	43.000	25.282	1083.381	3783.297
4	422.066	164.816	37.829	97085.929	19196.235	4	421.992	164.860	37.937	76321.666	15471.093
5	1.749	70.678	4.356	97085.929	19196.235	5	1.749	70.666	4.350	76321.666	15471.093
6	770.004	0.358	0.000	97213.929	19361.234	6	769.414	0.358	0.000	76449.666	15636.093
7	8617.035	0.356	0.380	97338.725	20217.568	7	8615.973	0.462	0.380	76553.974	16459.178
8	26857.849	82.118	40.000	97705.725	20265.568	8	26863.677	99.129	40.000	76920.974	16507.178
9	0.000	104.098	241.397	95493.187	17279.032	9	0.000	120.198	258.496	116261.828	21020.323
10	2.647	76.088	0.000	0.000	0.000	10	1.098	88.408	0.000	0.000	0.000
11	252.878	186.205	281.396	0.000	0.000	11	235.866	219.326	298.496	0.000	0.000
12	0.962	3.459	3.595	0.000	183199.293	12	0.962	3.457	3.592	0.000	158656.150
13	1.256	0.000	91.399	0.000	47636168.000	13	1.449	0.000	108.499	0.000	57980191.500
1	215.000	461.735	83.198	544.933	32.600	1	260.000	461.882	82.785	544.666	32.600
2	229995.17	40.499	26.891	130.227	331.535	2	229723.37	40.479	25.743	118.791	303.064
3	5.550	43.154	26.373	1344.561	4545.914	3	5.570	43.400	25.300	1050.719	3687.821
4	422.062	164.815	37.837	96777.519	18781.992	4	421.760	164.870	37.950	74013.337	15057.485
5	1.749	70.676	4.355	96777.519	18781.992	5	1.749	70.666	4.350	74013.337	15057.485
6	769.845	0.358	0.000	96905.519	18946.991	6	768.713	0.358	0.000	74141.337	15222.485
7	8616.586	0.356	0.380	95028.037	19799.628	7	8613.851	0.461	0.380	74243.367	16041.879
8	26857.329	83.897	40.000	95935.037	19847.628	8	26861.513	101.435	40.000	74610.367	16089.879
9	0.000	104.098	243.297	97092.084	17695.073	9	0.000	121.998	260.831	119570.645	21435.287
10	2.647	76.078	0.000	0.000	0.000	10	1.098	88.408	0.000	0.000	0.000
11	261.098	189.774	283.296	0.000	0.000	11	233.560	223.422	300.831	0.000	0.000
12	0.962	3.458	3.594	0.000	180470.664	12	0.962	3.456	3.591	0.000	155928.246
13	1.274	0.000	93.299	0.000	4878640.300	13	1.473	0.000	110.834	0.000	59129385.500
1	220.000	461.655	83.180	544.835	32.600	1	265.000	462.058	82.805	544.863	32.600
2	229951.68	40.269	26.748	128.959	328.372	2	229803.43	40.934	25.986	117.661	299.962
3	5.550	42.962	26.736	1311.092	4450.613	3	5.580	44.000	25.550	1018.726	3592.188
4	422.058	164.820	37.850	92469.509	18367.838	4	421.764	164.880	37.962	71703.951	14643.849
5	1.749	70.676	4.355	92469.509	18367.838	5	1.750	70.658	4.350	71703.951	14643.849
6	769.726	0.358	0.000	92597.509	18532.837	6	768.958	0.359	0.000	71831.951	14808.849
7	8616.137	0.356	0.380	92717.750	19381.778	7	8614.684	0.460	0.380	71931.793	15626.551
8	26856.819	84.674	40.000	93084.750	19429.778	8	26866.699	103.738	40.000	72298.703	15622.551
9	0.000	107.668	245.197	101110.581	18111.023	9	0.000	123.778	264.181	120880.519	21849.265
10	2.165	77.668	0.000	0.000	0.000	10	0.711	93.778	0.000	0.000	0.000
11	249.320	193.343	285.196	0.000	0.000	11	231.257	227.515	304.190	0.000	0.000
12	0.962	3.457	3.594	0.000	177742.527	12	0.963	3.457	3.591	0.000	153199.254
13	1.294	0.000	95.199	0.000	49936						

TABLE AP 5-4 (Sheet 5 of 7)
 PREDICTED S-IVB-206 PROPULSION SYSTEM PERFORMANCE
 COMPUTER PROGRAM AA89

1	280.000	461.888	82.831	544.719	32.600	1	375.000	370.765	77.757	448.522	-10.400
2	229768.08	40.553	26.711	113.425	290.409	2	197468.49	40.061	31.013	101.540	262.754
3	5.576	43.765	26.300	919.909	3305.112	3	4.768	43.910	30.667	653.954	2465.415
4	421.796	164.910	38.000	64775.619	13402.594	4	429.117	165.010	38.125	45969.350	9777.526
5	1.750	70.655	4.348	64775.619	13402.594	5	1.709	70.647	4.346	45969.350	9777.526
6	768.860	0.358	0.000	64903.619	13567.594	6	659.325	0.358	0.000	46097.350	9942.526
7	8613.696	0.358	0.000	64906.534	14372.217	7	7964.747	0.450	1.186	46171.708	10714.794
8	26869.204	109.167	40.000	65363.334	14420.217	8	25166.677	126.646	40.000	47566.708	10762.794
9	0.000	129.148	274.230	127810.317	23091.549	9	0.000	146.258	318.158	146619.033	26705.045
10	0.223	99.148	0.000	0.000	0.000	10	-0.484	115.258	0.000	0.000	0.000
11	225.828	238.313	314.239	0.000	0.000	11	208.893	271.358	358.157	0.000	0.000
12	0.962	3.456	0.592	0.000	145011.750	12	0.863	2.873	3.328	0.000	122529.502
13	1.584		174.234	0.000	63724937.500	13	1.571		168.162	0.000	73252120.000
1	285.000	461.594	82.827	544.421	26.331	1	330.000	369.339	77.752	447.991	-11.400
2	279648.92	40.383	26.952	112.033	287.243	2	191942.26	40.368	31.861	100.295	259.773
3	5.573	43.646	26.950	887.219	3209.376	3	4.768	43.746	31.900	627.334	2374.641
4	421.822	164.920	38.012	62467.389	12988.791	4	429.313	165.036	38.155	4275.999	8995.329
5	1.750	70.655	4.348	62467.389	12988.791	5	1.708	70.648	4.346	44119.119	9386.360
6	768.544	0.358	0.000	62595.389	13153.791	6	657.841	0.358	0.000	44247.119	9551.359
7	8611.949	0.349	0.670	62686.026	13954.721	7	7955.005	0.448	1.166	44319.652	10320.136
8	26865.568	110.914	40.000	63053.026	14002.721	8	25143.896	120.946	40.000	44688.652	10368.136
9	0.000	130.938	277.500	130119.035	23905.695	9	0.000	147.048	324.738	148469.229	27093.821
10	0.061	100.938	0.000	0.000	0.000	10	-0.471	117.064	0.000	0.000	0.000
11	224.080	241.851	317.580	0.000	0.000	11	204.648	275.597	364.038	0.000	0.000
12	0.962	3.454	3.591	0.000	142283.746	12	0.861	2.864	3.325	0.000	120282.788
13	1.614		127.584	0.000	64873446.000	13	1.596		174.642	0.000	74213120.000
1	290.000	461.365	82.823	544.128	20.062	1	335.000	367.919	77.735	445.654	-12.400
2	279539.58	40.211	27.193	110.643	284.077	2	191408.96	40.676	32.476	99.030	256.793
3	5.570	43.526	26.800	854.549	3113.628	3	4.773	44.617	32.440	601.214	2283.904
4	421.849	164.920	38.035	60160.618	12575.008	4	429.511	165.036	38.155	4275.999	8995.329
5	1.749	70.654	4.348	60160.618	12575.008	5	1.708	70.648	4.346	4275.999	8995.329
6	768.233	0.358	0.000	60288.618	12740.008	6	656.326	0.358	0.000	42403.999	9160.328
7	8610.233	0.348	0.670	60376.979	13537.244	7	7945.179	0.447	1.146	42474.713	9925.615
8	26862.017	112.658	40.000	60743.979	13585.244	8	25170.776	120.946	40.000	42841.713	9973.615
9	0.000	132.728	280.930	132426.291	23959.695	9	0.000	148.837	329.586	159312.447	27463.651
10	-0.100	102.728	0.000	0.000	0.000	10	-0.453	118.838	0.000	0.000	0.000
11	227.336	245.385	320.930	0.000	0.000	11	204.410	279.421	369.819	0.000	0.000
12	0.962	3.452	3.599	0.000	139557.223	12	0.860	2.855	3.322	0.000	118043.328
13	1.645		130.934	0.000	66021404.000	13	1.622		179.824	0.000	7517484.000
1	295.000	453.705	82.437	536.142	13.792	1	340.000	367.116	77.731	444.847	-13.000
2	274650.13	30.997	27.433	109.248	280.913	2	191111.72	40.988	32.820	97.710	253.817
3	5.564	43.407	27.050	821.986	3017.943	3	4.723	44.960	32.490	575.187	2193.312
4	427.265	164.920	38.037	57861.488	12161.563	4	429.512	165.046	38.155	4269.338	8604.515
5	1.747	70.653	4.347	57861.488	12161.563	5	1.707	70.649	4.346	42403.938	8749.515
6	769.215	0.358	0.000	57989.488	12326.563	6	655.488	0.358	0.000	42567.338	8749.515
7	8554.117	0.348	0.670	58075.573	13120.109	7	7939.532	0.444	1.127	42636.260	9531.313
8	26721.656	114.399	40.000	58442.573	13168.109	8	2518.556	120.946	40.000	42903.260	9579.313
9	0.000	134.518	280.200	134725.908	24333.607	9	0.000	152.627	335.602	152149.131	27870.101
10	-0.259	104.518	0.000	0.000	0.000	10	-0.434	120.628	0.000	0.000	0.000
11	220.556	248.916	324.280	0.000	0.000	11	207.178	283.442	375.502	0.000	0.000
12	0.954	3.404	3.568	0.000	136838.682	12	0.859	2.851	3.320	0.000	115810.553
13	1.655		134.284	0.000	67166297.000	13	1.650		185.506	0.000	76127388.000
1	300.000	425.239	80.419	505.659	7.523	1	345.000	367.385	77.783	445.168	-12.800
2	214472.99	39.743	27.806	107.856	277.794	2	191250.40	41.001	33.163	96.389	250.839
3	5.588	43.287	27.443	790.914	2923.439	3	4.723	45.012	32.840	549.170	2122.685
4	424.146	164.920	38.050	55667.604	11753.255	4	429.614	165.058	38.185	38603.435	8213.651
5	1.755	70.652	4.347	55667.604	11753.255	5	1.707	70.649	4.346	38731.435	8378.651
6	773.653	0.358	0.000	55795.604	11918.556	6	656.926	0.358	0.000	38731.435	8378.651
7	8349.276	0.347	1.199	55879.532	12708.461	7	7941.298	0.334	1.107	38798.525	9136.961
8	26174.752	116.135	40.000	56246.532	12756.461	8	25116.513	120.946	40.000	39165.525	9184.961
9	0.000	136.308	288.410	136920.158	24741.125	9	0.000	152.418	341.085	153985.955	28259.956
10	-0.377	106.308	0.000	0.000	0.000	10	-0.416	122.418	0.000	0.000	0.000
11	218.859	252.442	328.410	0.000	0.000	11	207.229	287.181	381.085	0.000	0.000
12	0.924	3.218	3.483	0.000	134230.992	12	0.859	2.853	3.321	0.000	113578.486
13	1.588		138.414	0.000	68267751.000	13	1.684		191.889	0.000	77083128.000
1	305.000	401.451	79.210	480.660	1.254	1	350.000	368.069	77.856	445.926	-12.300
2	204828.29	39.519	28.413	106.547	274.740	2	191557.48	40.813	33.806	95.667	247.858
3	5.068	43.167	28.052	761.699	2830.457	3	4.728	44.866	33.190	523.116	2011.989
4	426.139	164.962	38.065	53603.845	11352.255	4	429.573	165.070	38.220	36764.810	7822.557
5	1.729	70.650	4.347	53603.845	11352.255	5	1.708	70.650	4.346	36764.810	7822.557
6	695.429	0.358	0.000	53731.845	11517.255	6	656.873	0.358	0.000	36892.810	7987.557
7	8180.952	0.346	1.190	53813.737	12303.578	7	7946.728	0.332	1.087	36958.086	8742.376
8	25730.833	117.867	40.000	54180.737	12351.578	8	25132.243	120.946	40.000	37375.086	8790.376
9	0.000	138.998	294.360	138984.144	25140.058	9	0.000	154.207	346.869	155823.705	28649.051
10	-0.065	108.998	0.000	0.000	0.000	10	-0.394	126.208	0.000	0.000	0.000
11	217.127	245.944	334.340	0.000	0.000	11	198.542	290.438	386.569	0.000	0.000
12	0.898	3.067	3.415	0.000	131760.314	12	0.860	2.857	3.323	0.000	111343.462
13	1.555		144.364	0.000	69314068.000	13	1.720		196.573	0.000	78040123.000
1	310.000	388.470	78.563	466.993	-2.857	1	355.000	368.560	77.993	446.452	-11.920
2	190560.51	39.334	29.019	105.297	271.722	2	191768.86	40.627	33.835	93.691	244.885
3	4.944	43.048	28.661	733.791	2738.552	3	4.731	44.710	33.528	497.041	1921.543
4	427.331	164.974	38.080	51633.728	10955.641	4	429.549	165.101	38.232	34923.005	7431.228
5	1.718	70.648	4.347	51633.728	10955.641	5	1.708	70.647	4.346	34923.005	7431.228
6	669.050	0.358	0.000	51761.728	11120.641	6	657.494	0.358	0.000	35151.005	7596.228
7	8080.085	0.346	1.190	51841.676	11903.425	7	7950.791	0.331	1.075	35114.464	8347.555
8	25489.186	119.596	40.000	52208.676	11951.425	8	25145.468	120.946	40.000	35481.464	8395.555
9	0.000	139.888	300.310	140954.436	25534.262	9	0.000	155.997	351.962	157665.537	29038.479
10	-0.480	109.888	0.000	0.000	0.000	10	-0.376	125.998	0.000	0.000	0.000
11	215.308	249.487	340.310	0.000	0.000	11	198.542	290.438	386.569	0.000	0.000
12	0.884	2.984	3.377	0.000	129388.100	12	0.860	2.860	3.325	0.000	109105.019
13	1.542		150.314	0.000	70324008.000	13	1.758		201.966	0.000	78998536.000
1	315.000	379.900									

TABLE AP 5-4 (Sheet 6 of 7)
 PREDICTED S-IVB-206 PROPULSION SYSTEM PERFORMANCE
 COMPUTER PROGRAM AA89

1	377.360	367.878	77.888	445.716	-12.200	1	415.000	367.013	77.852	444.865	-12.200
2	191491.72	47.075	34.768	90.403	235.950	2	19161.42	38.747	38.855	73.777	208.340
3	4.723	44.270	34.488	418.762	1649.774	3	4.714	43.125	36.680	185.548	833.925
4	429.627	165.194	38.328	29394.699	6256.861	4	429.707	165.478	38.655	17933.942	2738.999
5	1.707	70.638	4.342	29394.699	6256.861	5	1.707	70.617	4.333	17933.942	2738.999
6	656.700	0.358	0.000	29572.699	8421.861	6	656.737	0.358	0.000	13061.042	2903.999
7	7947.131	70.325	1.075	29590.763	7162.706	7	7945.688	70.300	1.075	11192.863	3613.445
8	25143.437	143.007	40.000	29947.703	7210.706	8	25164.756	157.262	40.000	13469.803	3661.445
9	0.000	161.367	368.056	163193.928	39207.203	9	0.000	177.477	416.461	17955.719	33708.090
10	-0.321	131.368	0.000	0.000	0.000	10	-0.118	147.477	0.000	0.000	0.000
11	191.987	394.373	498.966	0.000	0.000	11	177.788	384.766	454.448	0.000	0.300
12	0.858	2.856	3.323	0.000	102386.008	12	0.858	2.851	3.321	0.000	82359.267
13	1.870	218.090	0.000	81875163.000	0.000	13	2.321	266.465	0.000	90455687.000	0.000
1	375.000	366.967	77.850	444.818	-12.700	1	427.000	368.087	77.902	445.984	-11.450
2	19147.18	39.797	35.079	87.847	232.971	2	191591.44	38.488	37.043	71.528	204.573
3	4.714	44.133	34.898	397.748	1559.153	3	4.725	43.033	36.890	159.554	743.084
4	429.720	165.225	38.360	27557.729	5865.631	4	429.593	165.500	38.700	11095.325	2347.720
5	1.707	70.636	4.341	27557.729	5865.631	5	1.718	70.614	4.332	11095.325	2347.720
6	656.697	0.358	0.000	27685.729	6130.631	6	656.901	0.358	0.000	11223.325	2512.720
7	7941.808	70.323	1.075	27761.928	6767.984	7	7952.958	70.300	1.075	11263.222	3218.683
8	25131.105	144.627	40.000	28108.920	6815.984	8	25189.434	158.801	40.000	11630.272	3266.683
9	0.000	163.157	373.461	165930.920	30596.550	9	0.000	179.267	421.835	181493.459	34097.477
10	-0.300	133.158	0.000	0.000	0.000	10	-0.087	149.267	0.000	0.000	0.000
11	191.366	397.783	413.461	0.000	0.000	11	176.111	385.266	461.835	0.000	0.300
12	0.858	2.851	3.323	0.000	100152.004	12	0.860	2.857	3.324	0.000	801285.000
13	1.909	223.465	0.000	82831735.000	0.000	13	2.391	271.840	0.000	91412545.000	0.000
1	380.000	366.108	77.811	443.910	-13.200	1	425.000	368.964	77.936	446.080	-10.800
2	190801.63	39.797	35.079	86.205	230.003	2	191939.99	38.417	37.231	69.244	200.775
3	4.715	44.086	35.006	366.790	1468.549	3	4.734	42.942	37.898	133.386	852.093
4	429.812	165.256	38.302	25725.955	5474.589	4	429.629	165.260	38.740	9252.504	1954.240
5	1.706	70.633	4.340	25725.955	5474.589	5	1.708	70.664	4.330	9252.504	1956.240
6	654.699	0.358	0.000	25853.955	5639.589	6	654.002	0.358	0.000	9380.504	2121.240
7	7935.987	70.325	1.075	25907.039	6373.589	7	7959.725	70.300	1.075	9418.534	2823.240
8	25118.726	146.250	40.000	26274.439	6421.452	8	25212.736	160.300	40.000	9785.534	2823.240
9	0.000	164.947	378.836	166863.613	30985.708	9	0.000	181.057	477.210	183393.309	34487.085
10	-0.278	134.968	0.000	0.000	0.000	10	-0.169	151.057	0.000	0.000	0.000
11	188.754	311.185	418.836	0.000	0.000	11	176.663	341.385	467.210	0.000	0.000
12	0.857	2.845	3.318	0.000	97923.901	12	0.861	2.863	3.326	0.000	77885.333
13	1.948	229.860	0.000	83786583.000	0.000	13	2.464	277.214	0.000	92371444.000	0.000
1	385.000	365.443	77.780	443.242	-13.560	1	430.000	369.310	77.942	447.252	-10.500
2	190560.885	39.797	35.076	84.746	227.042	2	192070.87	38.600	37.421	66.541	196.573
3	4.718	44.089	35.336	360.987	1377.966	3	4.738	42.857	37.289	107.236	561.080
4	429.800	165.287	38.424	23896.458	5083.742	4	429.629	165.260	38.740	7466.386	1861.080
5	1.706	70.631	4.339	23896.458	5083.742	5	1.708	70.699	4.328	7466.386	1564.641
6	653.926	0.358	0.000	24024.458	5248.742	6	654.375	0.358	0.000	7534.386	1729.641
7	7931.865	0.327	1.075	24077.338	5979.116	7	7962.690	0.303	1.075	7570.694	2428.606
8	25110.252	147.861	40.000	24464.038	6027.116	8	25294.978	161.800	40.000	7937.694	2476.606
9	0.000	166.737	384.211	168692.225	31374.668	9	0.000	182.847	430.585	185192.457	34878.805
10	-0.254	136.738	0.000	0.000	0.000	10	-0.152	152.847	0.000	0.000	0.000
11	187.152	314.677	424.211	0.000	0.000	11	173.143	344.695	472.585	0.000	0.000
12	0.857	2.841	3.317	0.000	95699.153	12	0.861	2.866	3.327	0.000	75642.300
13	1.991	234.215	0.000	84739784.000	0.000	13	2.539	282.589	0.000	93331634.000	0.000
1	380.000	365.138	77.745	442.903	-13.710	1	435.000	369.197	77.973	447.120	-10.500
2	190410.64	39.797	35.815	83.067	224.087	2	192014.71	38.604	37.613	63.696	191.959
3	4.715	44.095	35.076	315.013	1287.362	3	4.738	42.758	37.880	81.768	470.005
4	429.814	165.310	38.456	22669.964	4692.992	4	429.648	165.260	38.740	9565.168	1861.080
5	1.706	70.628	4.338	22669.964	4692.992	5	1.708	70.650	4.327	9565.168	1173.097
6	653.545	0.358	0.000	22797.964	4857.992	6	654.199	0.358	0.000	9688.168	1338.097
7	7931.813	0.318	1.075	22248.741	5584.879	7	7962.388	0.301	1.075	9772.635	2033.568
8	25107.292	147.861	40.000	22615.741	5632.879	8	25294.978	163.367	40.000	6089.635	2081.568
9	0.000	168.527	389.586	17518.730	31763.531	9	0.000	182.627	437.960	18702.637	35264.601
10	-0.230	138.528	0.000	0.000	0.000	10	-0.136	154.637	0.000	0.000	0.000
11	185.558	317.960	429.586	0.000	0.000	11	171.632	347.995	477.960	0.000	0.000
12	0.856	2.839	3.316	0.000	93476.628	12	0.861	2.864	3.326	0.000	73399.202
13	2.037	239.690	0.000	85692136.000	0.000	13	2.616	287.964	0.000	94291822.000	0.000
1	395.000	364.965	77.758	442.723	-13.760	1	440.000	369.390	77.921	447.311	-10.300
2	190341.66	39.797	36.043	81.355	221.115	2	192073.33	38.674	37.808	60.281	186.877
3	4.715	44.094	35.816	289.157	1196.603	3	4.741	42.667	37.680	54.898	378.854
4	429.813	165.360	38.458	20244.360	4302.308	4	429.648	165.260	38.740	38.048	3714.171
5	1.706	70.626	4.338	20244.360	4302.308	5	1.708	70.682	4.326	3714.171	781.628
6	653.344	0.358	0.000	20372.960	4467.308	6	654.390	0.358	0.000	3842.171	946.628
7	7939.267	0.316	1.075	20421.917	5190.707	7	7964.266	0.299	1.075	3874.836	1638.665
8	25108.294	147.861	40.000	20788.917	5238.707	8	25294.978	164.861	40.000	4241.836	1586.665
9	0.000	170.317	394.941	173443.766	32152.327	9	0.000	184.637	443.325	188874.716	35654.606
10	-0.204	140.318	0.000	0.000	0.000	10	-0.119	156.427	0.000	0.000	0.000
11	183.974	321.334	436.941	0.000	0.000	11	170.131	351.286	483.335	0.000	0.000
12	0.856	2.838	3.315	0.000	91255.623	12	0.861	2.866	3.326	0.000	71156.447
13	2.086	244.965	0.000	86643895.000	0.000	13	2.699	293.339	0.000	95251855.000	0.000
1	400.000	365.020	77.743	442.783	-13.660	1	445.000	370.791	77.976	448.767	-9.500
2	190366.76	39.797	36.270	79.642	218.125	2	192078.74	38.866	37.926	55.922	181.114
3	4.715	44.090	36.056	269.301	1105.994	3	4.745	42.575	37.890	28.678	287.609
4	429.800	165.380	38.520	18419.984	3911.615	4	429.621	165.264	38.740	1844.921	390.058
5	1.706	70.623	4.337	18419.984	3911.615	5	1.708	70.688	4.324	1844.921	390.058
6	653.415	0.358	0.000	18567.984	4076.615	6	654.000	0.358	0.000	1992.921	555.058
7	7939.087	0.314	1.075	18595.160	4796.527	7	7974.984	0.298	1.075	2023.761	1243.539
8	25112.899	152.593	40.000	18962.169	4884.527	8	25270.920	164.353	40.000	2390.761	1291.539
9	0.000	172.107	400.336	174168.732	32541.133	9	0.000	189.216	448.710	197724.920	36045.747
10	-0.179	142.108	0.000	0.000	0.000	10	-0.104	158.217	0.000	0.000	0.000
11	182.399	324.699	440.336	0.000	0.000	11	168.439	354.568	488.710	0.000	0.000
12	0.856	2.838	3.315	0.000	89934.687	12	0.863	2.874	3.330	0.000	68910.300
13	2.138	250.340	0.000	87595036.000	0.000	13	2.704	298.714	0.000	96213165.000	0.000
1	405.000	365.369	77.								

TABLE AP 5-4 (Sheet 7 of 7)
 PREDICTED S-IVB-206 PROPULSION SYSTEM PERFORMANCE
 COMPUTER PROGRAM AA89

1	450.073	373.376	78.110	451.486	-8.237	1	450.773	18.735	3.807	22.541	-8.057
2	194651.80	39.395	37.928	48.836	174.326	2	9036.09	42.184	37.739	48.192	173.991
3	4.780	42.482	37.800	1.903	194.728	3	4.927	47.469	37.800	0.675	190.379
4	431.134	165.964	39.000	-22.684	-7.757	4	400.868	165.957	39.000	-109.259	-26.389
5	1.710	70.554	4.325	-22.684	-7.757	5	1.710	70.551	4.325	-109.259	-26.389
6	652.267	0.358	0.000	105.316	157.243	6	30.277	0.358	0.000	18.741	138.611
7	7064.977	0.296	1.075	134.294	842.174	7	351.487	0.295	1.075	47.633	823.375
8	25084.782	167.857	40.000	591.294	890.174	8	1722.453	168.064	40.000	414.633	871.375
9	0.000	190.032	454.163	192411.672	36441.659	9	0.000	190.283	454.916	192690.282	36441.659
10	0.000	160.033	0.000	0.000	0.000	10	0.000	160.284	0.000	0.000	0.000
11	167.134	357.889	494.163	0.000	0.000	11	166.927	358.346	494.916	0.000	0.000
12	0.830	2.800	3.375	0.000	66619.467	12	0.854	0.140	0.164	0.000	66514.008
13	2.922		304.167		97193078.000	13	0.136		304.929		97237889.000
1	450.173	371.761	67.398	389.069	-8.207	1	450.873	16.441	3.326	19.767	-8.032
2	167835.82	38.698	37.566	48.589	174.186	2	7845.82	42.207	37.744	48.176	173.984
3	4.780	42.480	37.800	1.397	192.977	3	4.942	42.467	37.800	0.650	190.271
4	431.134	165.964	39.000	-58.348	-15.258	4	396.915	165.959	39.000	-111.061	-26.851
5	1.710	70.553	4.325	-58.348	-15.258	5	1.710	70.551	4.325	-111.061	-26.851
6	562.264	0.358	0.000	69.652	149.742	6	26.288	0.358	0.000	16.939	138.149
7	AC36.628	0.296	1.075	98.594	834.605	7	308.444	0.295	1.075	45.829	822.909
8	21615.517	167.887	40.000	465.594	882.605	8	1668.277	168.094	40.000	412.429	870.909
9	0.000	190.032	454.271	192647.336	36449.120	9	0.000	190.310	455.923	192690.450	36449.063
10	0.000	160.033	0.000	0.000	0.000	10	0.000	160.307	0.000	0.000	0.000
11	167.134	357.984	494.271	0.000	0.000	11	166.898	358.412	495.923	0.000	0.000
12	0.830	2.413	2.909	0.000	66576.199	12	0.858	0.123	0.144	0.000	66511.738
13	2.521		304.275		97211671.000	13	0.118		304.927		97238737.000
1	450.273	197.257	41.285	238.542	-8.182	1	450.973	13.718	2.611	15.629	-8.007
2	102670.64	38.295	37.098	48.413	174.086	2	6049.47	42.238	37.751	48.163	173.979
3	4.780	42.478	37.800	1.028	191.699	3	4.987	42.465	37.800	0.629	190.177
4	430.469	165.968	39.000	-84.422	-20.769	4	388.347	165.961	39.000	-112.576	-27.254
5	1.710	70.553	4.325	-84.422	-20.769	5	1.710	70.551	4.325	-112.576	-27.254
6	344.012	0.358	0.000	43.578	144.231	6	20.337	0.358	0.000	15.424	137.746
7	3760.783	0.296	1.075	72.495	829.746	7	244.241	0.295	1.075	44.313	822.503
8	13258.272	167.917	40.000	439.495	877.346	8	838.380	168.123	40.000	411.313	870.503
9	0.000	190.174	454.378	192673.398	36454.572	9	0.000	190.355	455.131	192701.330	36460.362
10	0.000	160.175	0.000	0.000	0.000	10	0.000	160.356	0.000	0.000	0.000
11	167.075	358.020	494.378	0.000	0.000	11	166.868	358.477	495.131	0.000	0.000
12	0.829	1.479	1.784	0.000	66544.540	12	0.865	0.090	0.113	0.000	66509.815
13	1.463		304.382		97225272.000	13	0.091		305.135		97239436.000
1	450.373	75.060	15.778	90.818	-8.157	1	451.073	0.100	1.810	11.093	-7.982
2	30098.34	39.549	37.189	48.297	174.035	2	6084.11	42.287	37.762	48.153	173.975
3	4.756	42.476	37.800	0.840	191.723	3	5.078	42.464	37.800	0.612	190.101
4	430.462	165.969	39.000	-97.666	-23.627	4	371.170	165.963	39.000	-113.720	-27.579
5	1.710	70.553	4.325	-97.666	-23.627	5	1.710	70.550	4.325	-113.720	-27.579
6	130.971	0.358	0.000	30.336	141.373	6	8.458	0.358	0.000	14.280	137.621
7	1407.843	0.296	1.075	59.238	826.162	7	172.469	0.295	1.075	43.168	822.175
8	5007.083	167.966	40.000	426.238	874.162	8	581.420	168.153	40.000	410.168	870.175
9	0.000	190.174	454.486	192686.621	36457.348	9	0.000	190.390	455.238	192702.439	36460.583
10	0.000	160.161	0.000	0.000	0.000	10	0.000	160.391	0.000	0.000	0.000
11	167.066	358.088	494.486	0.000	0.000	11	166.830	358.542	495.238	0.000	0.000
12	0.825	0.563	0.682	0.000	66528.399	12	0.881	0.060	0.078	0.000	66508.343
13	0.588		304.490		97232134.000	13	0.061		305.242		97239942.000
1	450.473	32.222	6.430	38.654	-8.132	1	451.173	6.186	1.181	7.366	-7.957
2	16031.07	41.360	37.555	48.258	174.018	2	2524.30	42.362	37.774	48.166	173.977
3	5.012	42.475	37.800	0.774	190.778	3	5.236	42.462	37.800	0.601	190.042
4	414.782	165.981	39.000	-102.973	-24.679	4	342.687	165.965	39.000	-114.513	-27.831
5	1.710	70.552	4.325	-102.973	-24.679	5	1.710	70.556	4.325	-114.513	-27.831
6	53.721	0.358	0.000	25.727	140.321	6	8.458	0.358	0.000	13.487	137.169
7	604.574	0.296	1.075	54.626	825.101	7	116.037	0.295	1.075	42.374	821.920
8	2064.812	167.976	40.000	421.626	873.101	8	370.347	168.182	40.000	409.374	869.920
9	0.000	190.176	454.593	192691.197	36458.311	9	0.000	190.426	455.346	192703.197	36460.730
10	0.000	160.174	0.000	0.000	0.000	10	0.000	160.427	0.000	0.000	0.000
11	167.016	358.150	494.593	0.000	0.000	11	166.809	358.495	495.346	0.000	0.000
12	0.870	0.242	0.278	0.000	66522.727	12	0.909	0.044	0.051	0.000	66507.294
13	0.261		304.597		97234525.000	13	0.038		305.350		97240266.000
1	450.573	23.785	4.883	28.648	-8.107	1	451.273	4.277	0.781	5.053	-7.932
2	11653.37	42.011	37.702	48.230	174.007	2	1533.65	42.386	37.784	48.142	173.970
3	4.891	42.473	37.800	0.735	190.624	3	5.471	42.460	37.800	0.593	189.995
4	406.785	165.983	39.000	-105.746	-25.339	4	303.805	165.967	39.000	-115.066	-28.034
5	1.710	70.552	4.325	-105.746	-25.339	5	1.710	70.550	4.325	-115.066	-28.034
6	39.066	0.358	0.000	22.954	139.661	6	5.139	0.358	0.000	12.934	136.966
7	446.227	0.295	1.075	51.859	824.435	7	80.153	0.295	1.075	41.820	821.715
8	1561.720	168.005	40.000	418.850	872.435	8	250.767	168.212	40.000	408.820	869.715
9	0.000	190.211	454.701	192693.936	36458.860	9	0.000	190.462	455.453	192703.717	36460.827
10	0.000	160.212	0.000	0.000	0.000	10	0.000	160.463	0.000	0.000	0.000
11	166.986	358.281	494.701	0.000	0.000	11	166.880	358.673	495.453	0.000	0.000
12	0.849	0.178	0.210	0.000	66519.285	12	0.906	0.030	0.034	0.000	66506.535
13	0.175		304.705		97235877.000	13	0.023		305.457		9724066.000
1	450.673	20.471	4.179	24.641	-8.082	1	451.373	0.000	0.000	0.000	-7.907
2	9935.87	42.136	37.720	48.210	173.998	2	0.000	42.413	37.790	48.130	173.960
3	4.909	42.471	37.800	0.703	190.496	3	0.000	42.459	37.800	0.588	189.950
4	403.219	165.955	39.000	-107.266	-25.888	4	0.000	165.969	39.000	-115.345	-28.188
5	1.710	70.552	4.325	-107.266	-25.888	5	1.710	70.549	4.325	-115.345	-28.188
6	33.291	0.358	0.000	20.736	139.112	6	0.000	0.295	0.000	12.615	136.812
7	384.269	0.295	1.075	49.628	823.881	7	0.000	0.295	1.075	41.501	821.500
8	1339.161	168.035	40.000	416.628	871.881	8	0.000	168.241	40.000	408.501	869.500
9	0.000	190.247	454.808	192696.123	36459.306	9	0.000	190.498	455.561	192704.000	36460.875
10	0.000	160.248	0.000	0.000	0.000	10	0.000	160.499	0.000	0.000	0.000
11	166.987	358.281	494.808	0.000	0.000	11	166.850	358.738	495.561	0.000	0.000
12	0.852	0.154	0.180	0.000	66516.509	12	0.900	0.000	0.000	0.000	66505.261
13	0.149		304.812		97236942.000	13	0.000		305.555		9724050.000

TABLE AP 5-5 (Sheet 1 of 3)
 DEFINITION OF SYMBOLS USED WITH COMPUTER PROGRAM AA89

PRINTOUT SYMBOL	DEFINITION
ASUBM	Stage axial acceleration, (g)
CSUBFEV	Vacuum thrust coefficient
DEL	PU valve position (deg)
DRAG	Atmospheric resistance to the motion of the vehicle
EMR	Total engine propellant mixture ratio. The ratio of the total engine LOX mass flowrate to the total engine LH2 mass flowrate
ENGINE ISP	Engine specific impulse (sec). Engine thrust divided by engine mass flowrate
FPS	LH2 pump speed (RPM)
FSUBAUX	Auxiliary thrust (lbf)
FSUBE	Stage thrust (lbf)
FUEL OVB	LH2 passed overboard through engine and vents (lbm)
GGMR	Gas generator mixture ratio
HSUBF	Height of LH2 above pump inlet (in); computed from height versus volume polynomial
HSUBO	Height of LOX above pump inlet (in); computed from height versus volume polynomial
IMPSUBT	Stage total impulse (lbf-sec)
LPS	LOX pump speed (RPM)
OXID OVB	LOX passed overboard through engine and vents (lbm)
PCC	Thrust chamber pressure (psia) (Injector static pressure)
PFPI	LH2 pump inlet pressure, total (psia)
POPI	LOX pump inlet pressure, total (psia)
RHOSUBF	LH2 bulk density (lbm/ft. ³); calculated from pump inlet temperature plus a bias

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TABLE AP 5-5 (Sheet 2 of 3)
 DEFINITION OF SYMBOLS USED WITH COMPUTER PROGRAM AA89

PRINTOUT SYMBOL	DEFINITION
RHOSUBO	LOX bulk density (lbm/ft ³); calculated from pump inlet temperature plus a bias
TFPI	LH2 pump inlet temperature (deg R)
TIME	Time from S-IVB stage engine start (sec)
TOPI	LOX pump inlet temperature (deg R)
TFHE	GHE in LH2 tank ullage (lbm)
TFH2	GH2 in LH2 tank ullage (lbm)
TTF	Total mass in LH2 tank ullage (lbm)
TTO	Total mass in LOX tank ullage (lbm)
TTOHE	GHE in LOX tank ullage (lbm)
TTOLOX	GOX in LOX tank ullage (lbm)
TTPSUBF	LH2 tank ullage pressure (psia)
TTPSUBO	LOX tank ullage pressure (psia)
VSUBF	LH2 volume in tank (ft ³)
VSUBO	LOX volume in tank (ft ³)
WDOTFBO	Rate of LH2 boiloff (lbm/sec)
WDOTFGG	Gas generator LH2 flowrate (lbm/sec)
WDOTFPR	LH2 tank pressurant flowrate (lbm/sec)
WDOTFVO	Rate of GH2 vented overboard (lbm/sec)
WDOTHE	LOX tank pressurant (GHe) flowrate (lbm/sec)
WDOTOBO	Rate of LOX boiloff (lbm/sec)
WDOTOGG	Gas generator LOX flowrate (lbm/sec)
WDOTOVO	Rate of GOX vented overboard (lbm/sec)
WDOTSUBF	Engine LH2 flowrate (lbm/sec)

TABLE AP 5-5 (Sheet 3 of 3)
 DEFINITION OF SYMBOLS USED WITH COMPUTER PROGRAM AA89

PRINTOUT SYMBOL	DEFINITION
WDOTSUBO	Engine LOX flowrate (lbm/sec)
WDOTSUBT	Total propellant consumption, includes auxiliary flows (lbm/sec)
WFBOT	Accumulated LH2 boiloff (lbm)
WF IN TANK	Weight of LH2 in tank (lbm)
WFPRT	Accumulated LH2 tank pressurant (lbm)
WF PU	PU indicated LH2 weight (lbm)
WFPU USABLE	PU indicated usable LH2 weight (lbm)
WF USABLE	Usable LH2 in tank (lbm)
WFOVOT	Total GH2 vented overboard (lbm)
WOBOT	Accumulated LOX boiloff (lbm)
WO IN TANK	Weight of LOX in tank (lbm)
WO PU	PU indicated LOX weight (lbm)
WOPU USABLE	PU indicated usable LOX weight (lbm)
WO USABLE	Usable LOX in tank (lbm)
WOVOT	Total GOX vented overboard (lbm)
WSUBFT	Total LH2 onboard (lbm)
WSUBHE	Weight of helium in cold helium spheres (lbm)
WSUBO ERROR	Equivalent LOX weight error, defined as LH2 weight (PU indicated) times reference mixture ratio of PU system, subtracted from LOX weight (PU indicated) (lbm)
WSUBOT	Total LOX onboard (lbm)
WSUBV	Total weight of S-IVB plus payload (lbm)

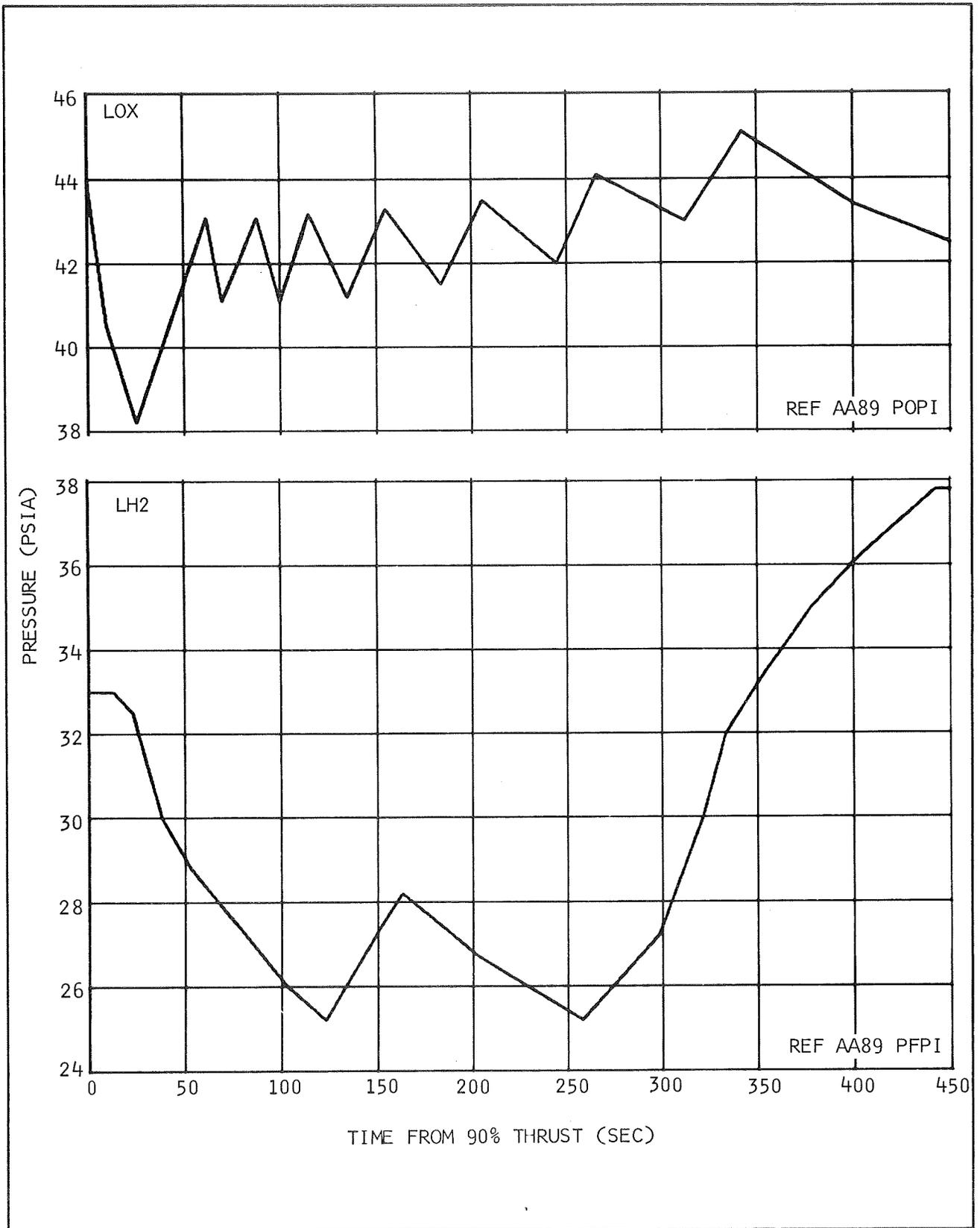


Figure AP 5-1. LOX and LH2 Pump Inlet Pressure

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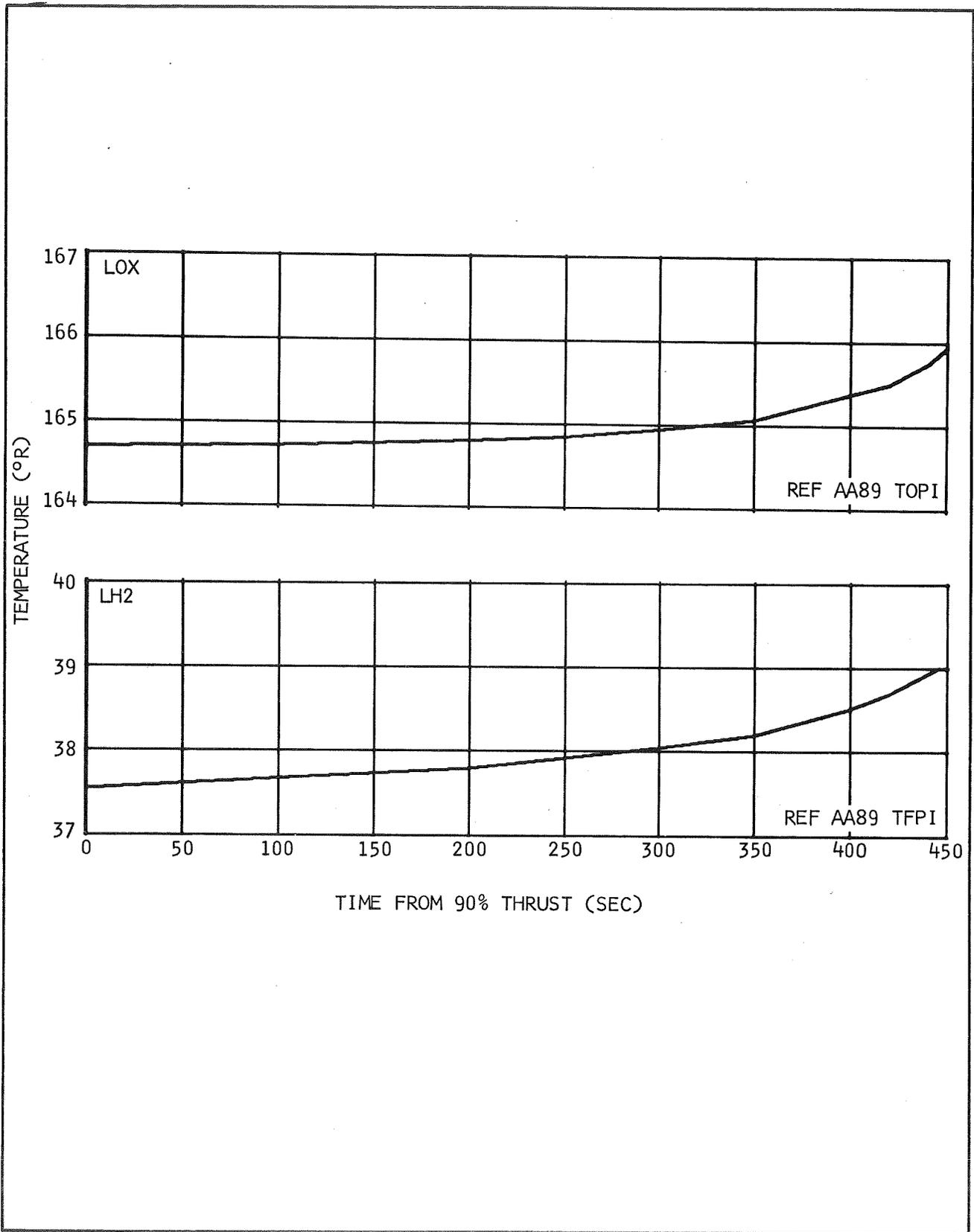
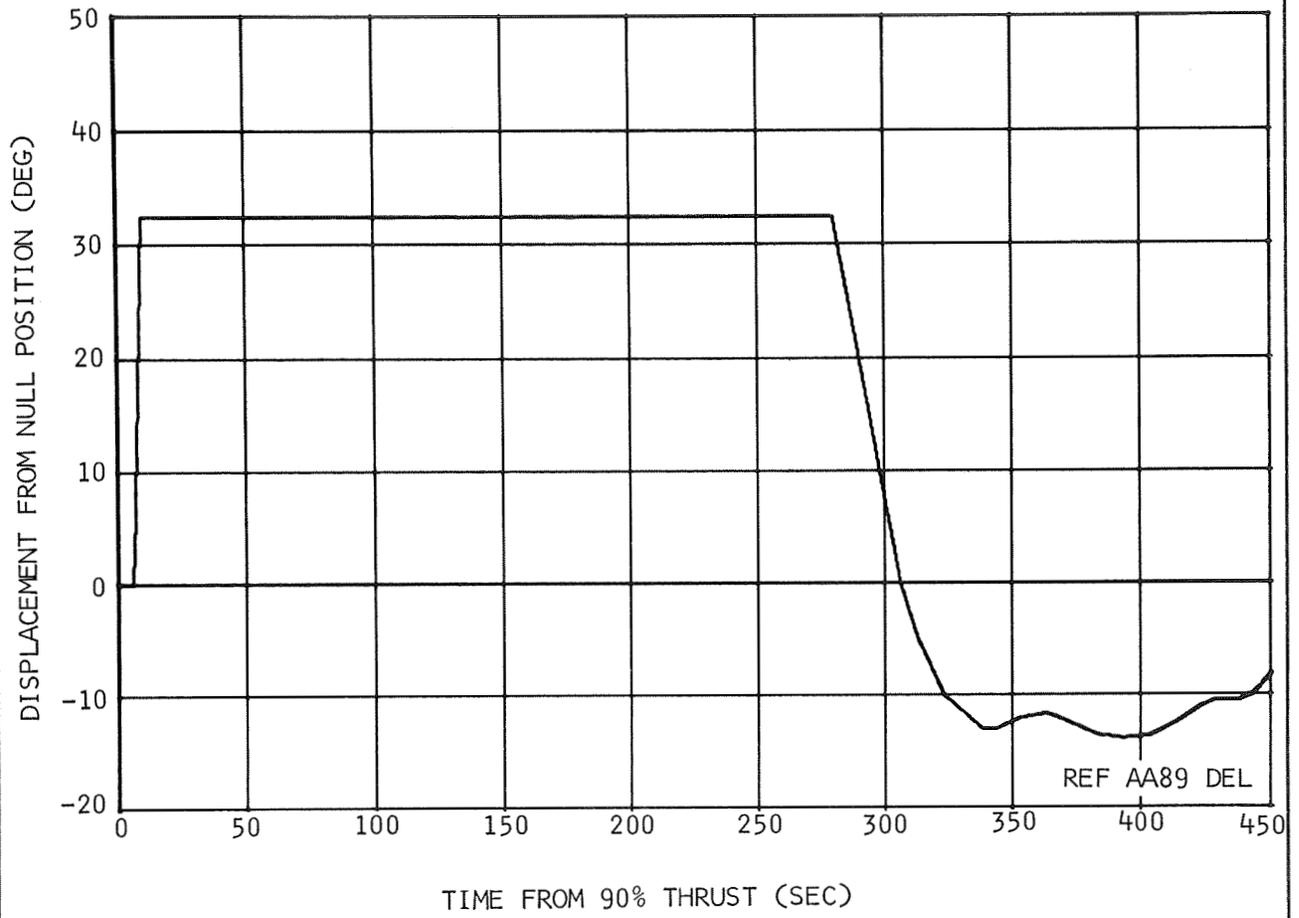


Figure AP 5-2. LOX and LH2 Pump Inlet Temperature



REF AA89 DEL

Figure AP 5-3. PU Valve Position

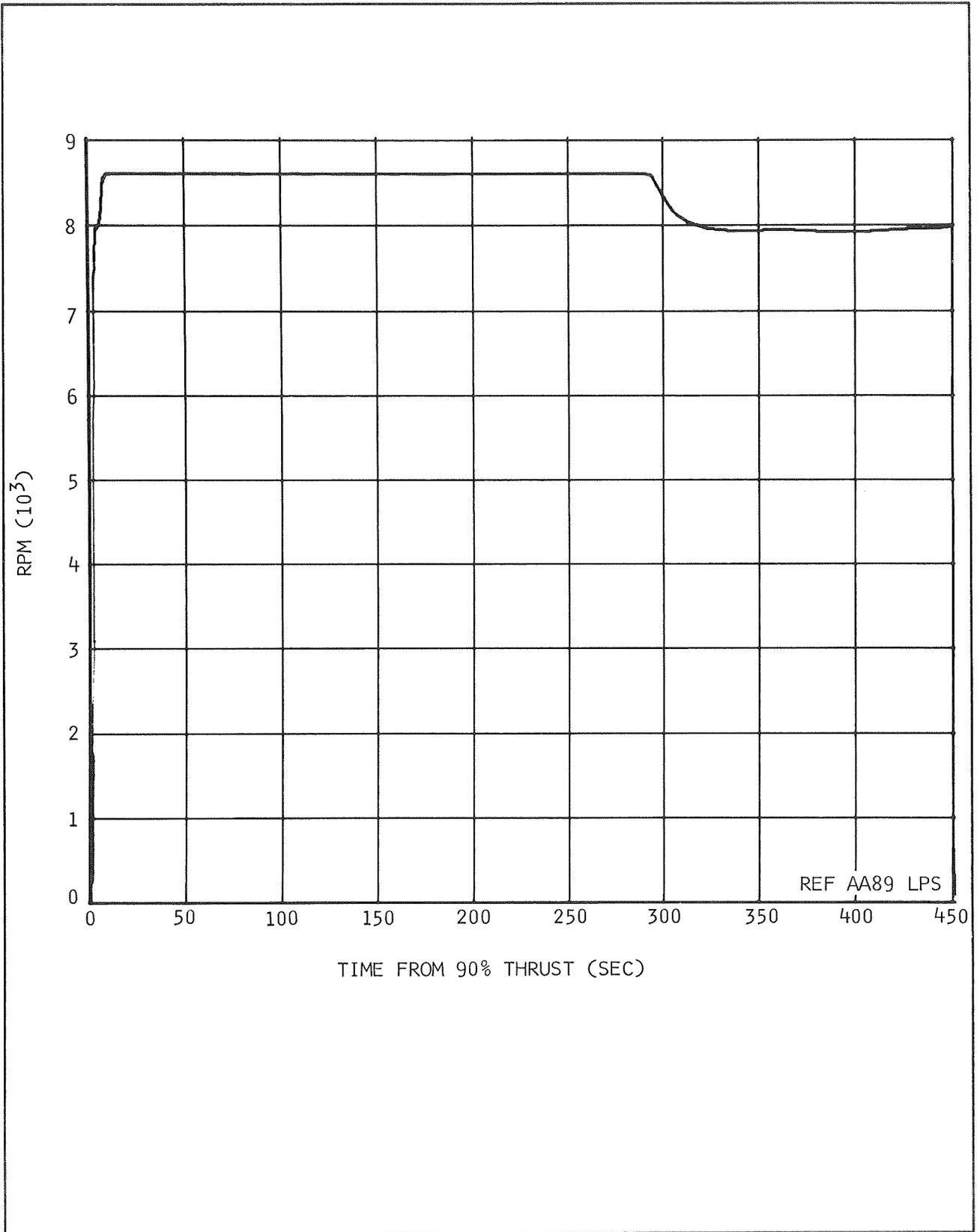


Figure AP 5-4. LOX Pump Speed

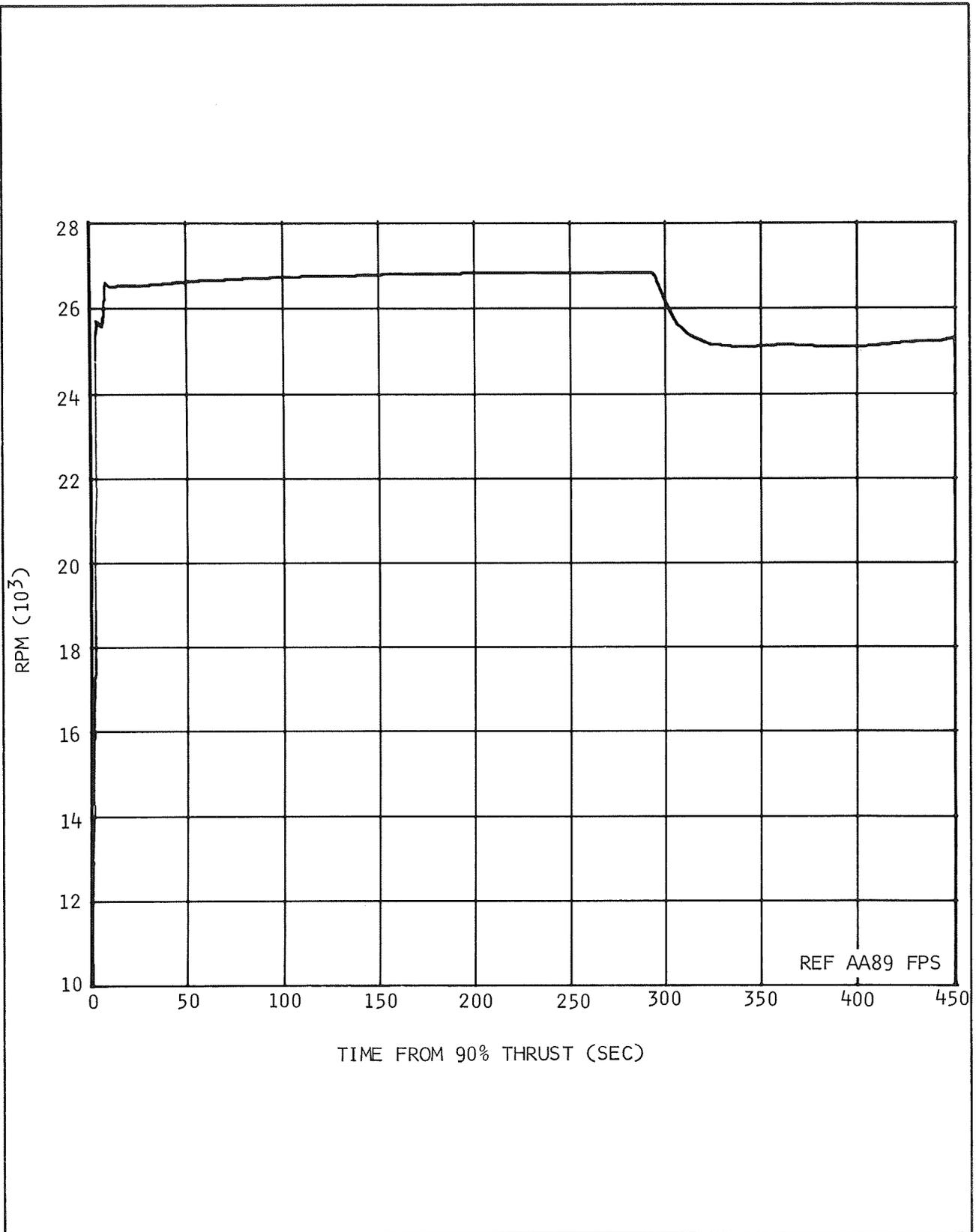


Figure AP 5-5. LH2 Pump Speed

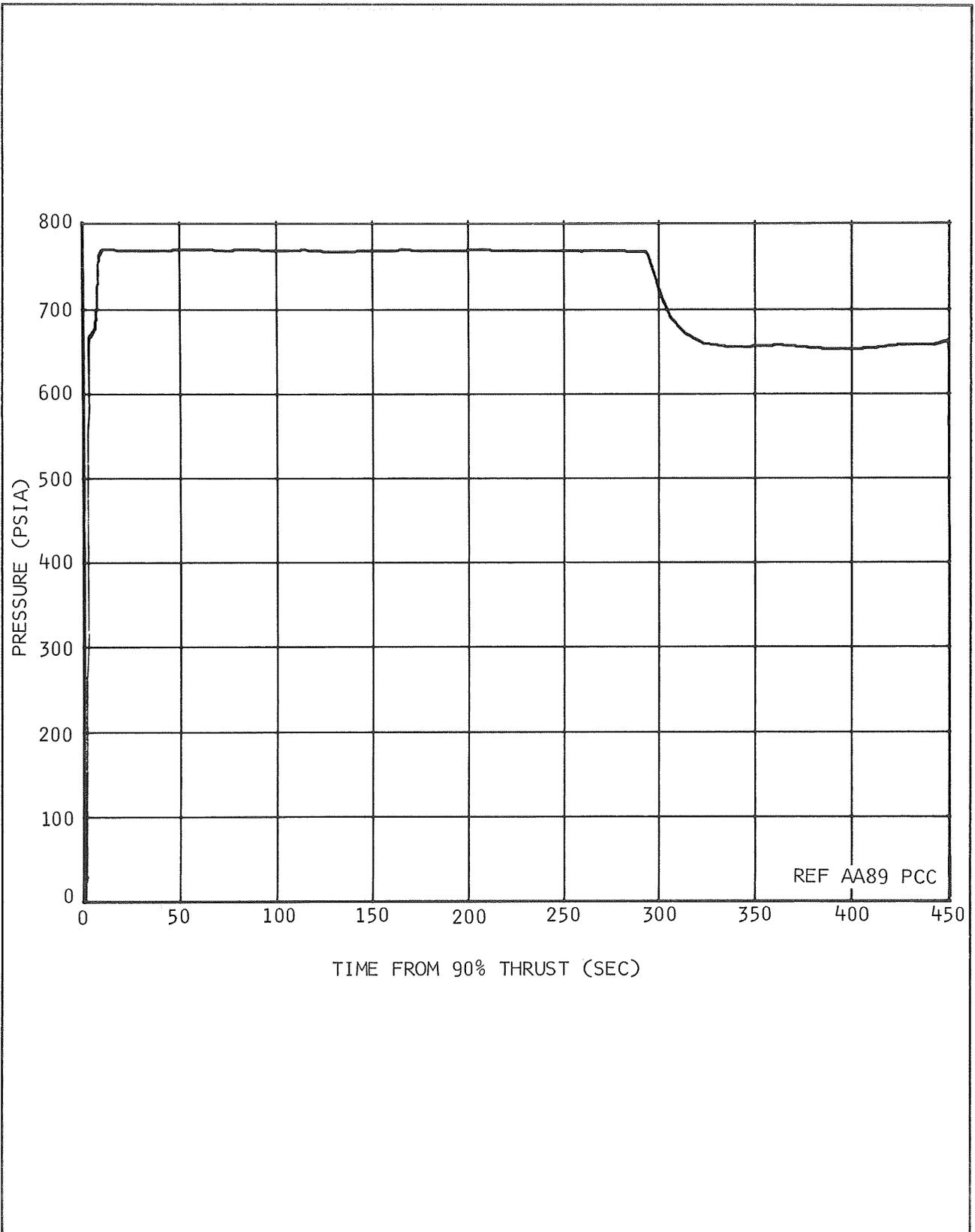


Figure AP 5-6. Thrust Chamber Pressure (Injector)

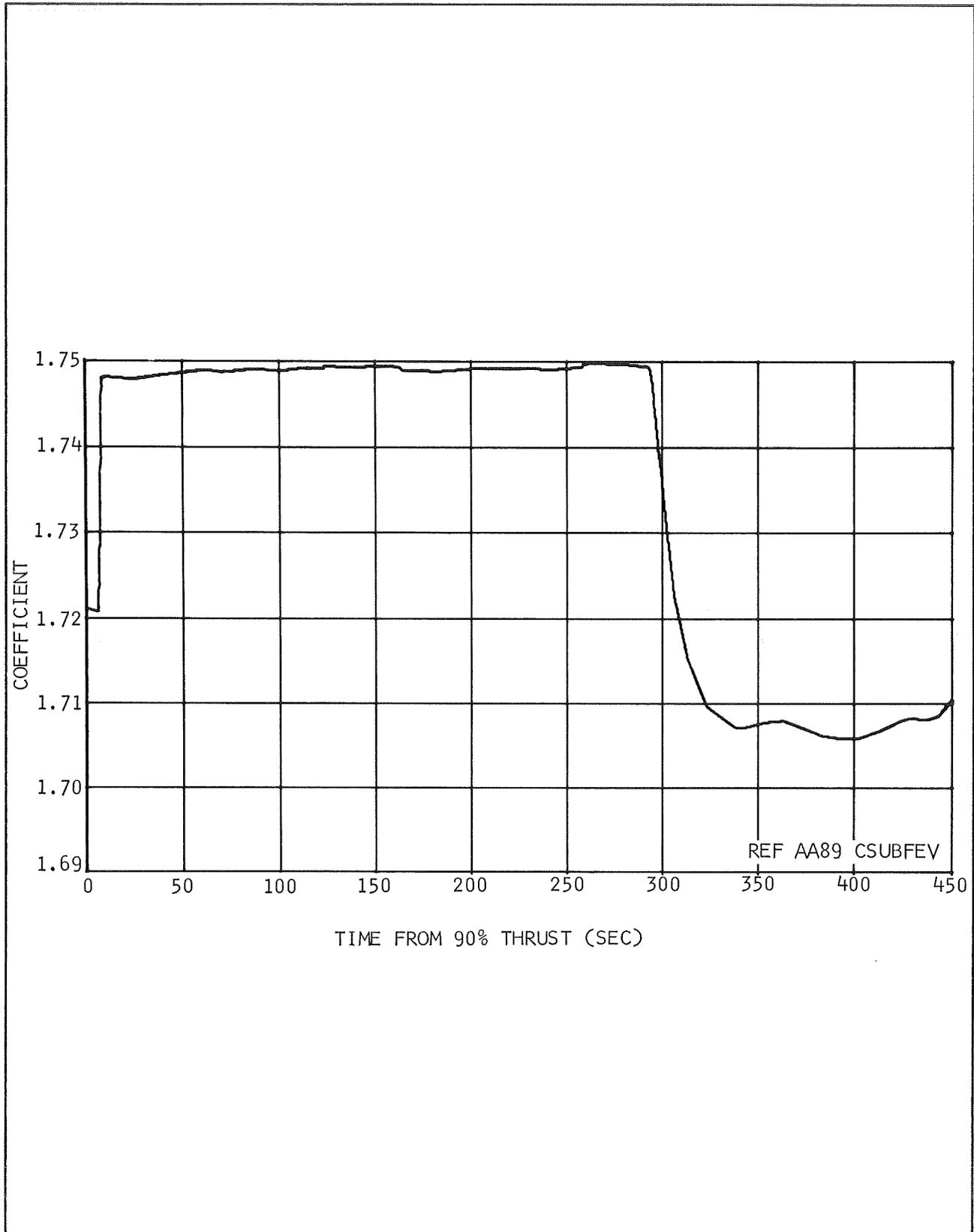


Figure AP 5-7. Vacuum Thrust Coefficient (Injector)

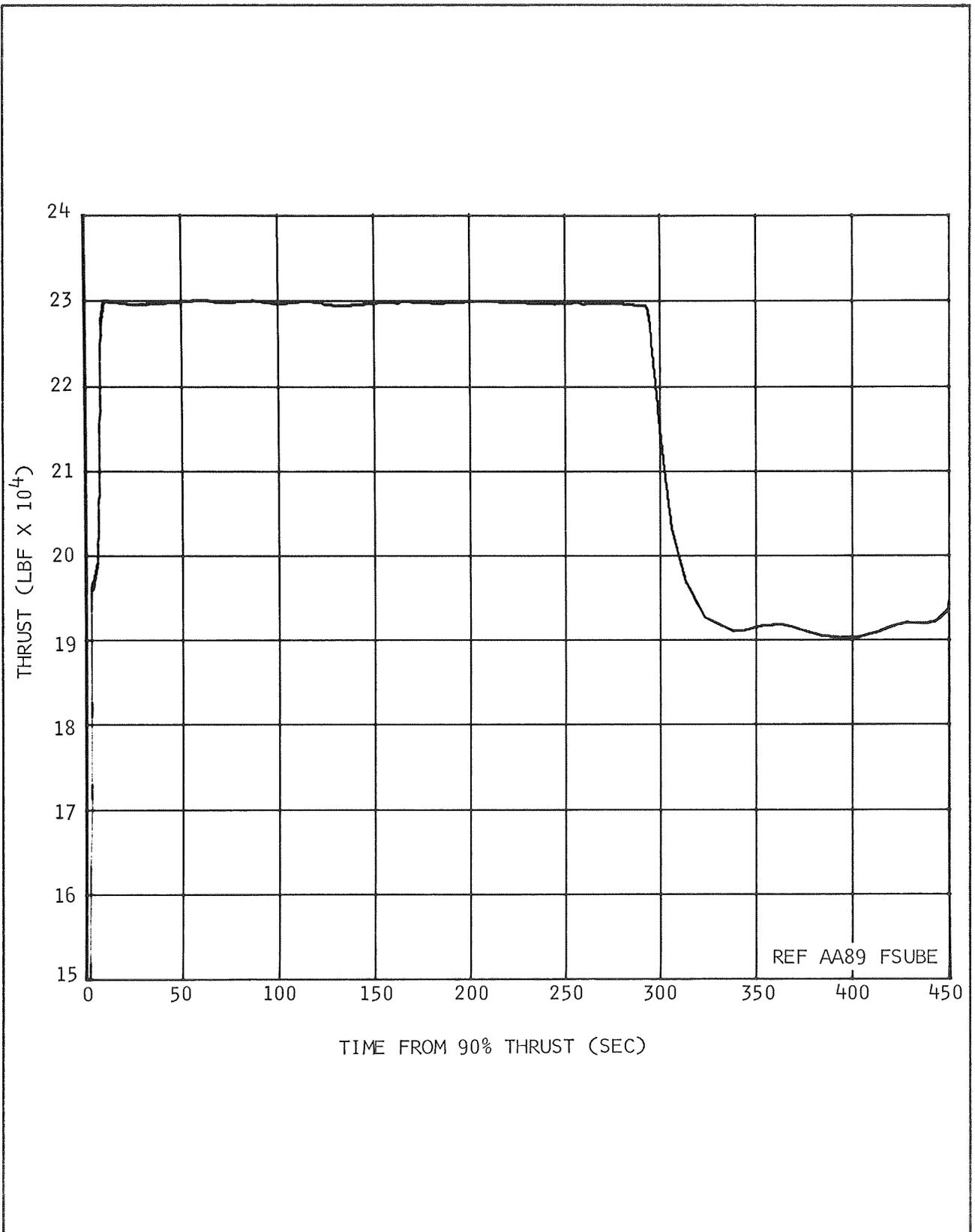


Figure AP 5-8. Engine Thrust

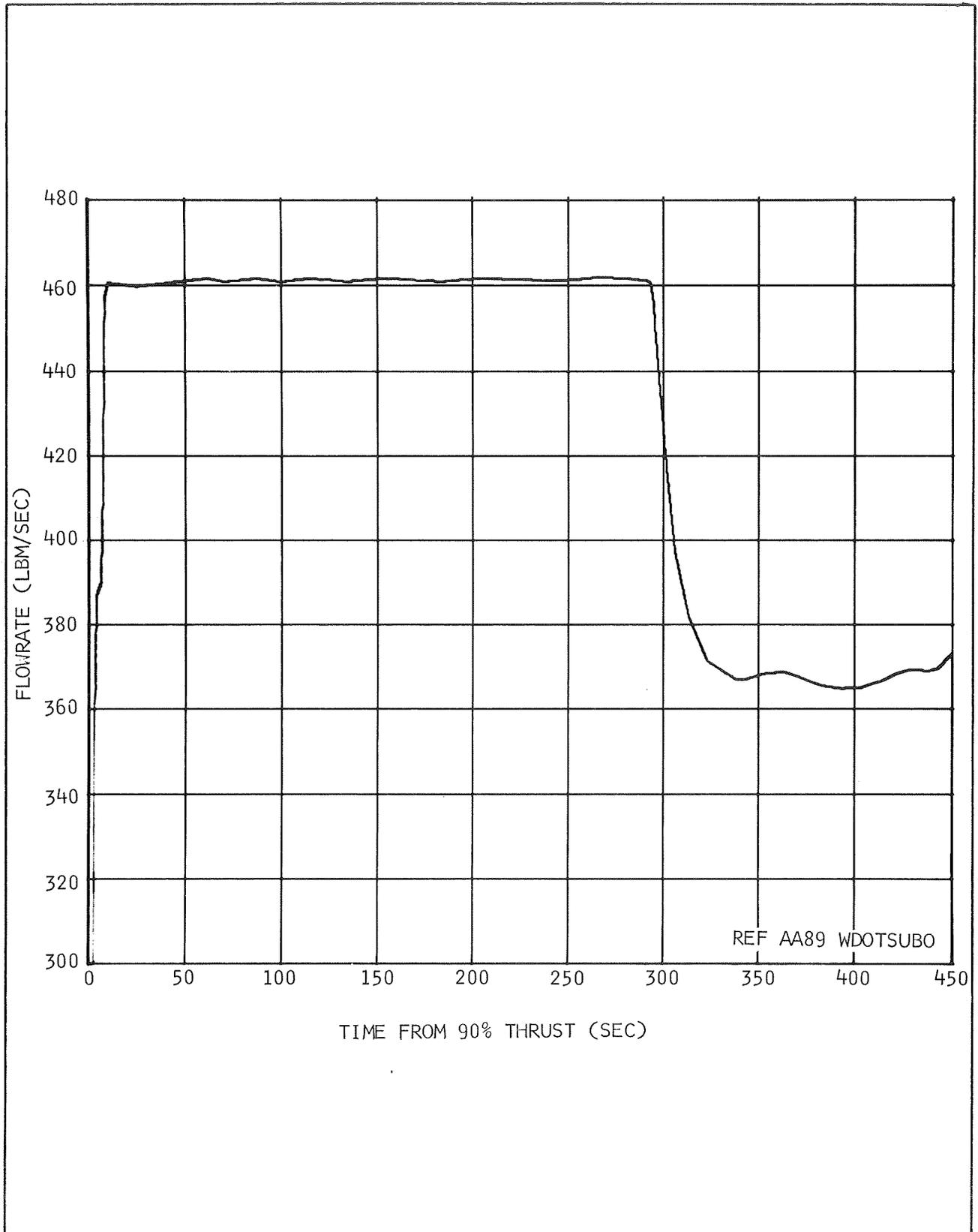


Figure AP 5-9. LOX Flowrate, Pump Inlet

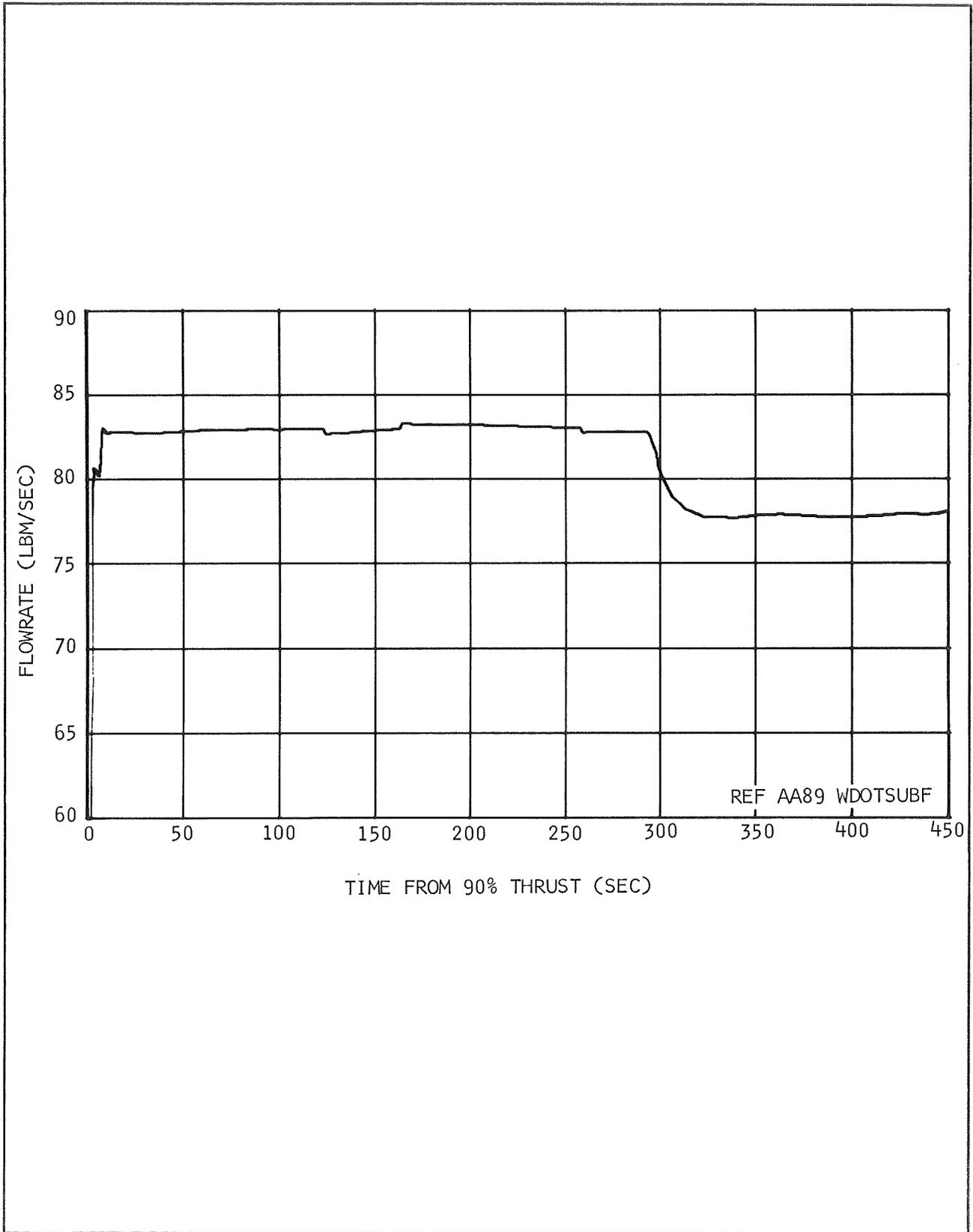


Figure AP 5-10. LH2 Flowrate, Pump Inlet

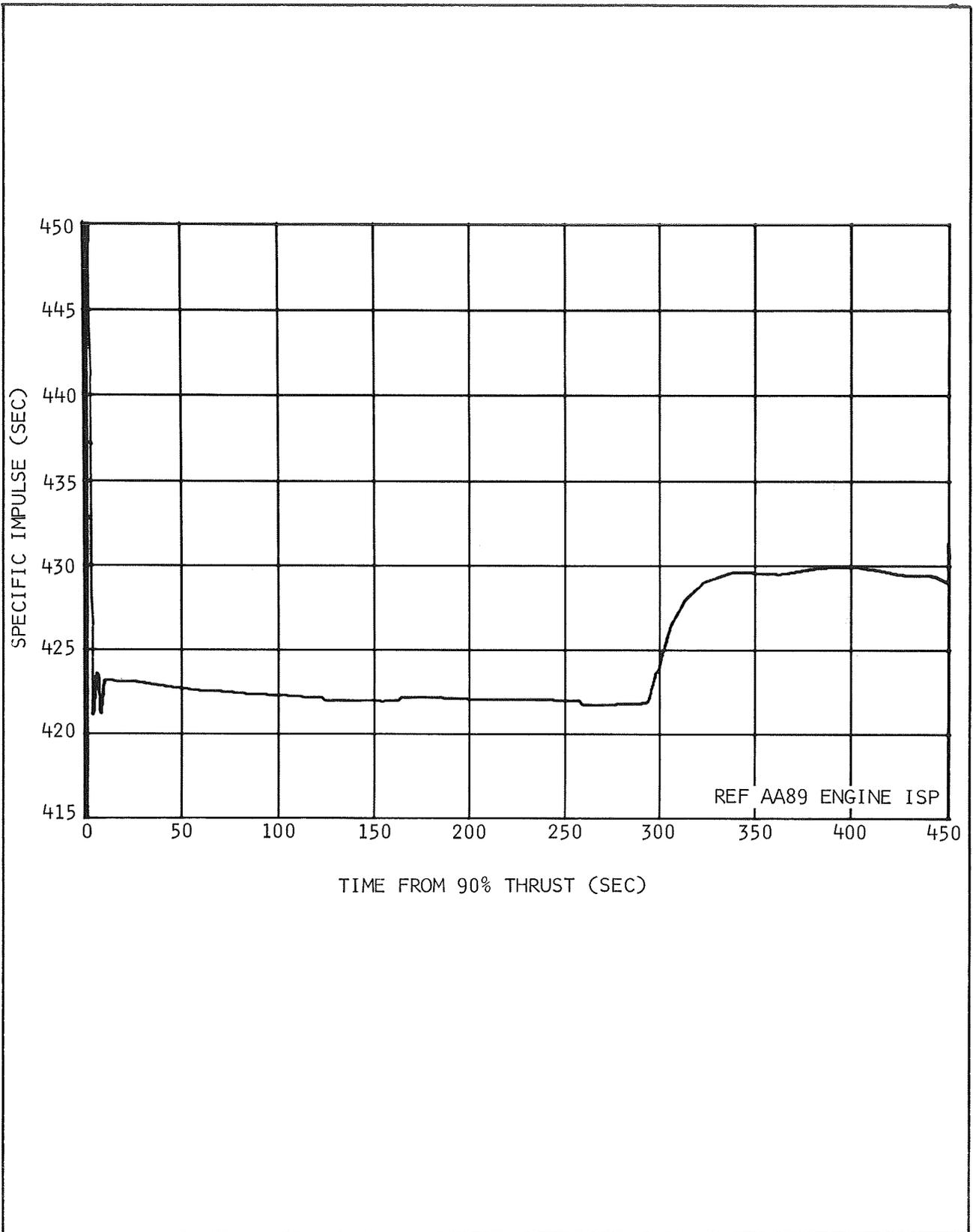


Figure AP 5-11. Engine Specific Impulse

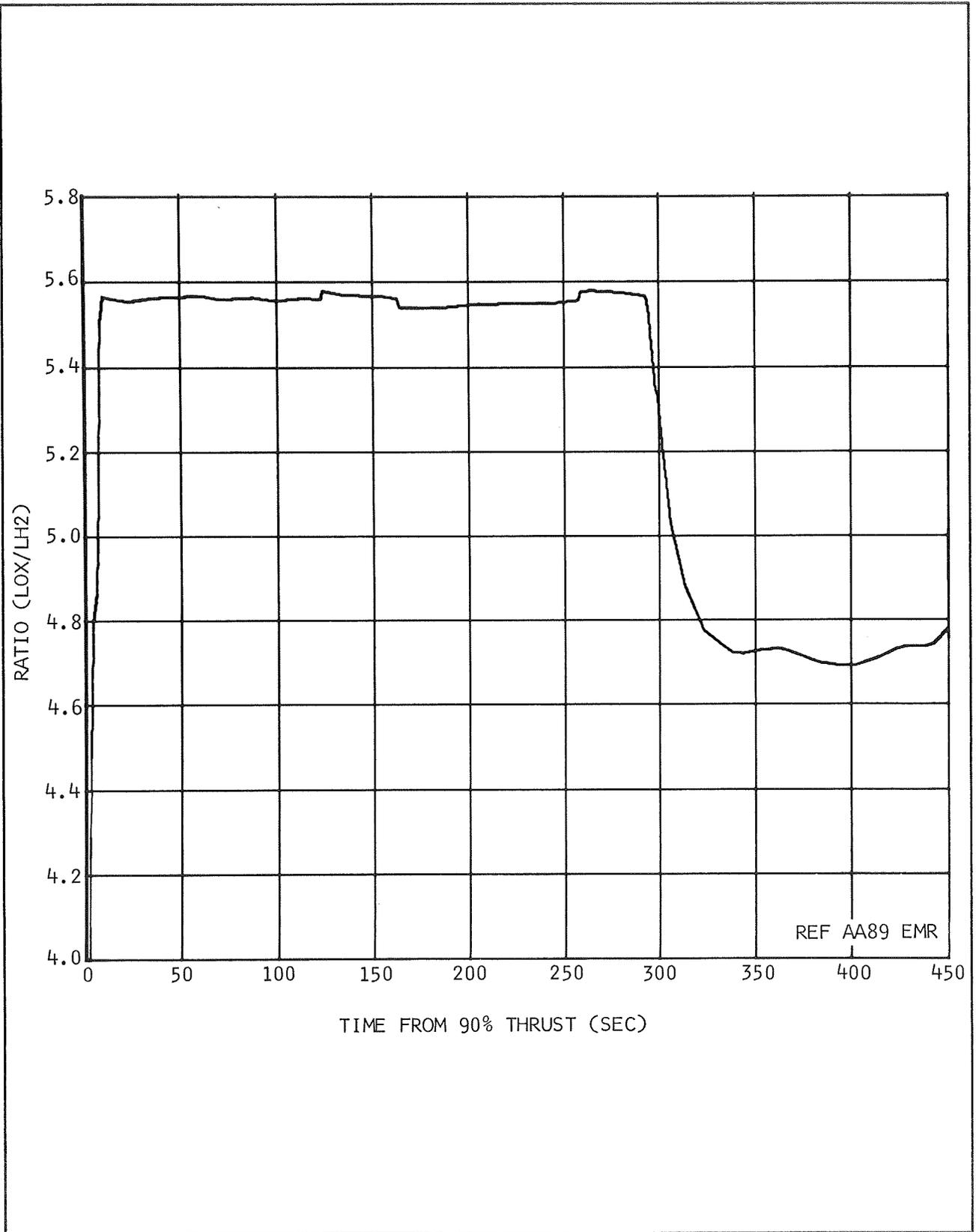


Figure AP 5-12. Engine Mixture Ratio

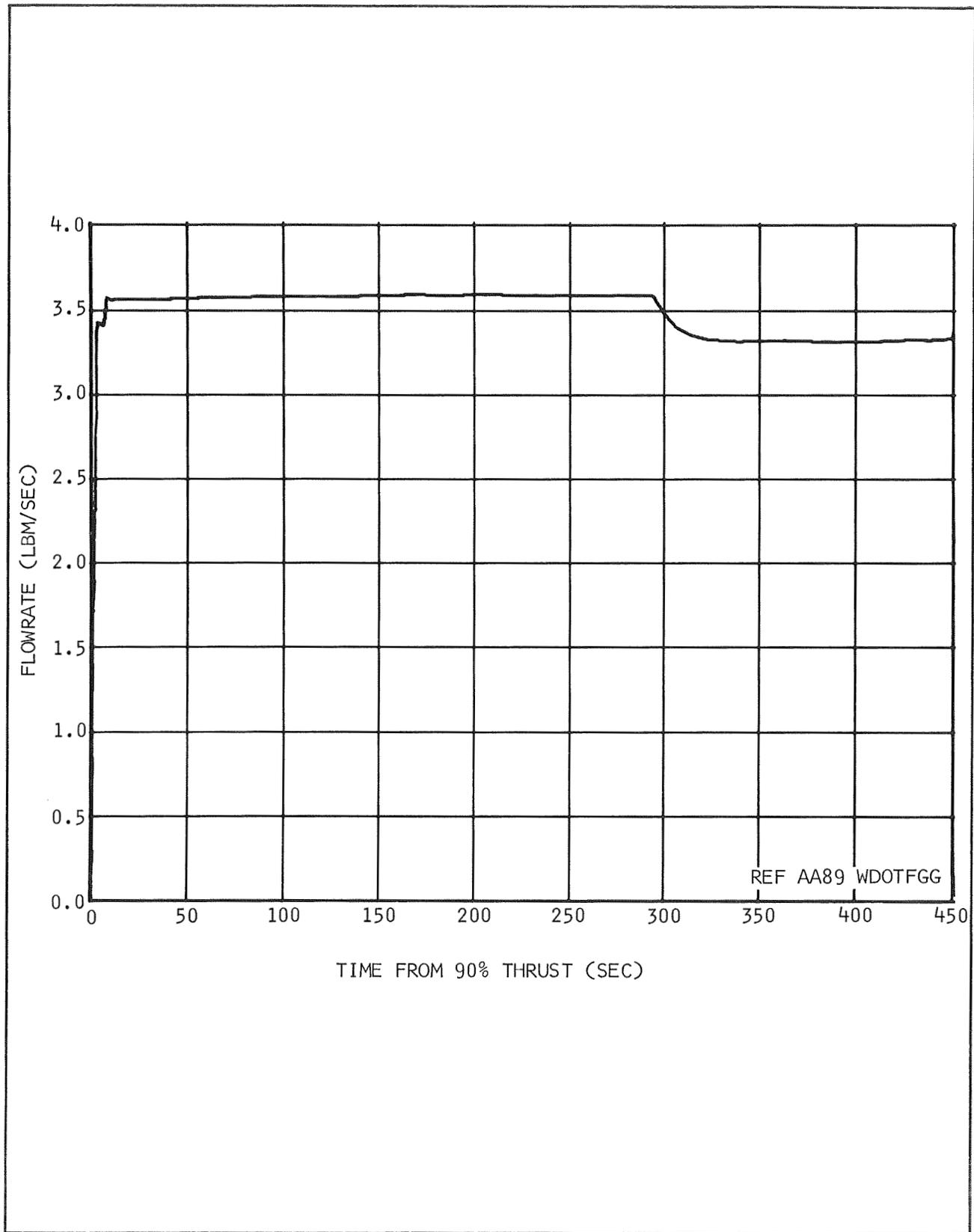


Figure AP 5-13. Gas Generator LH2 Flowrate

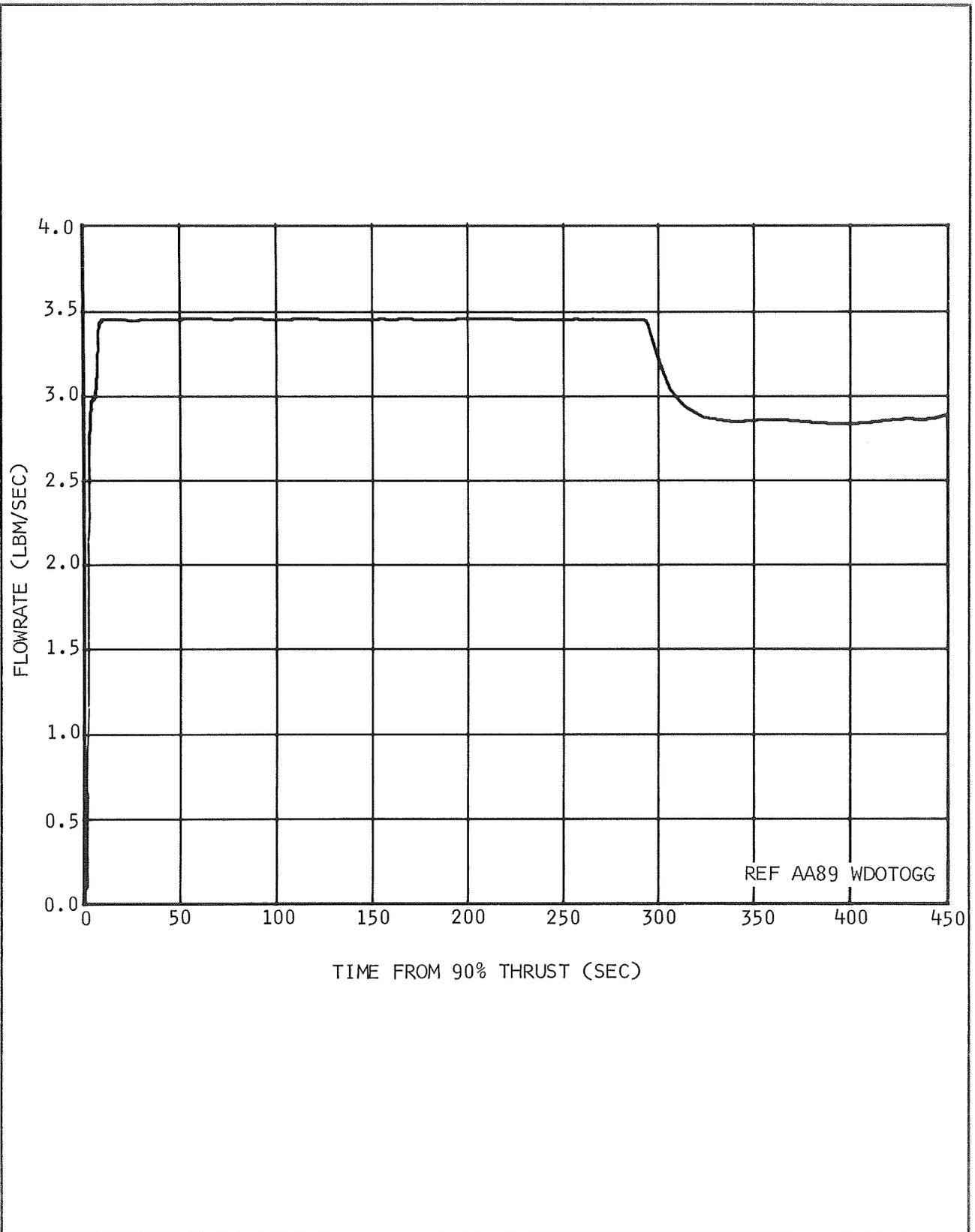


Figure AP 5-14. Gas Generator LOX Flowrate

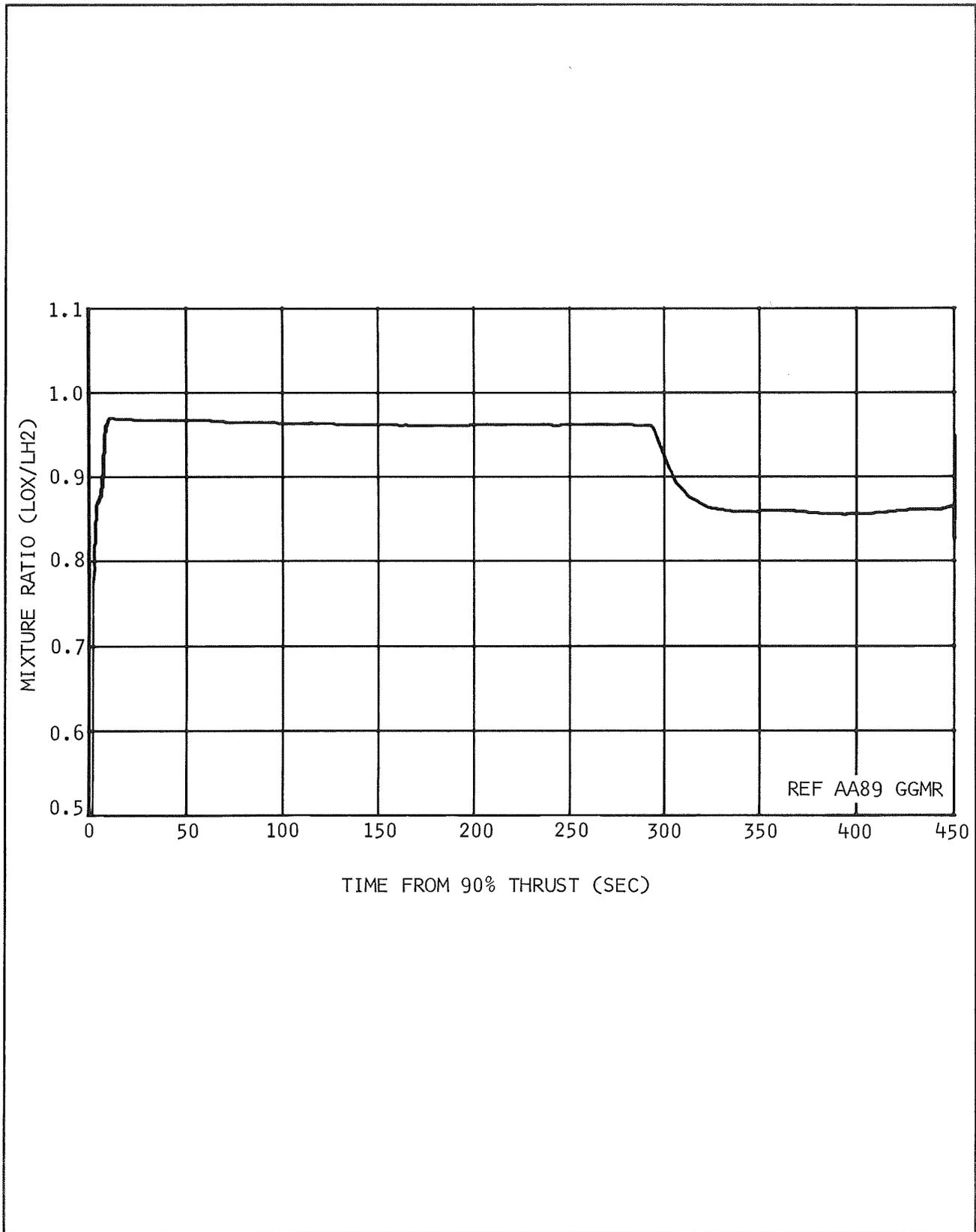


Figure AP 5-15. Gas Generator Mixture Ratio

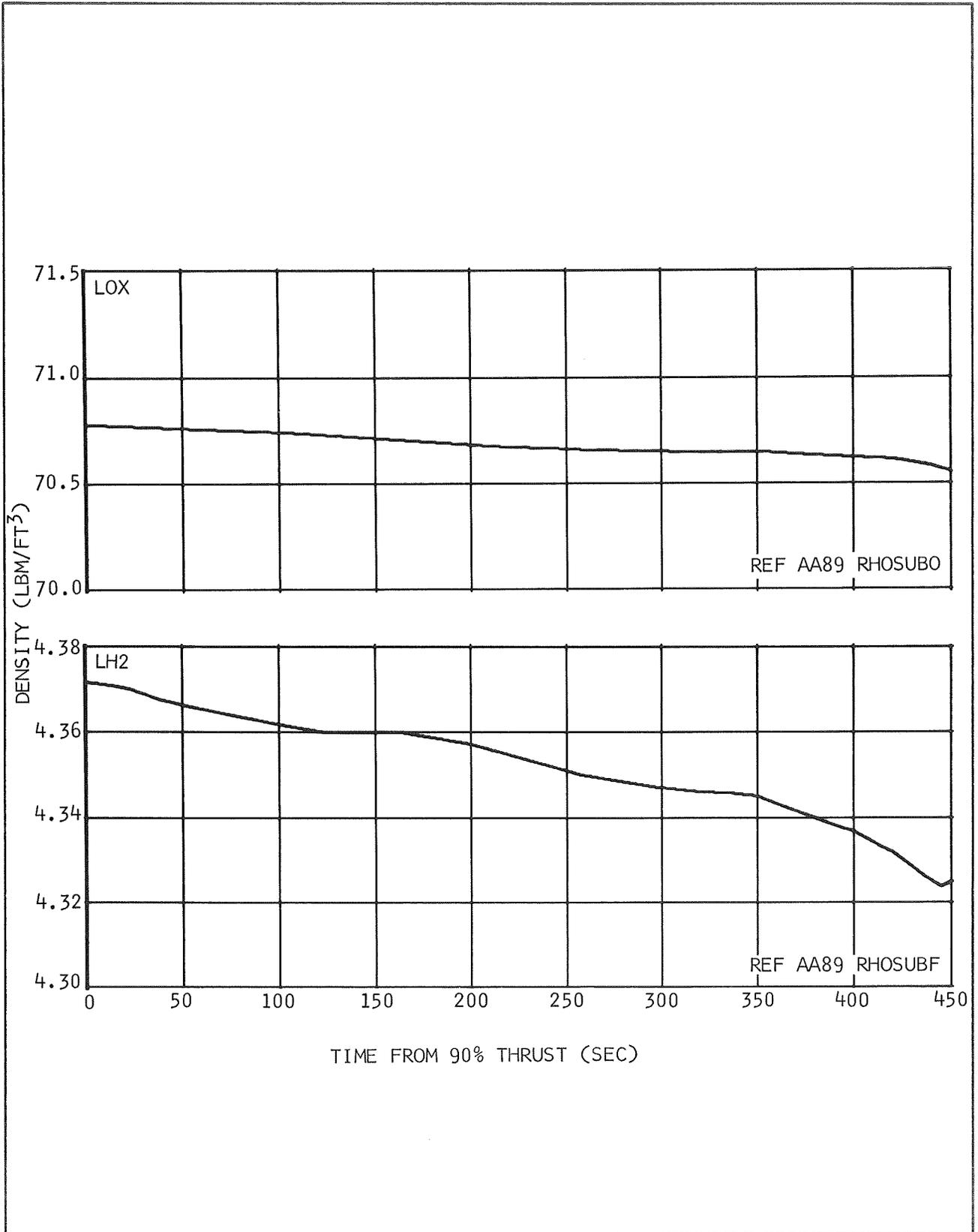


Figure AP 5-16. LOX and LH2 Bulk Densities

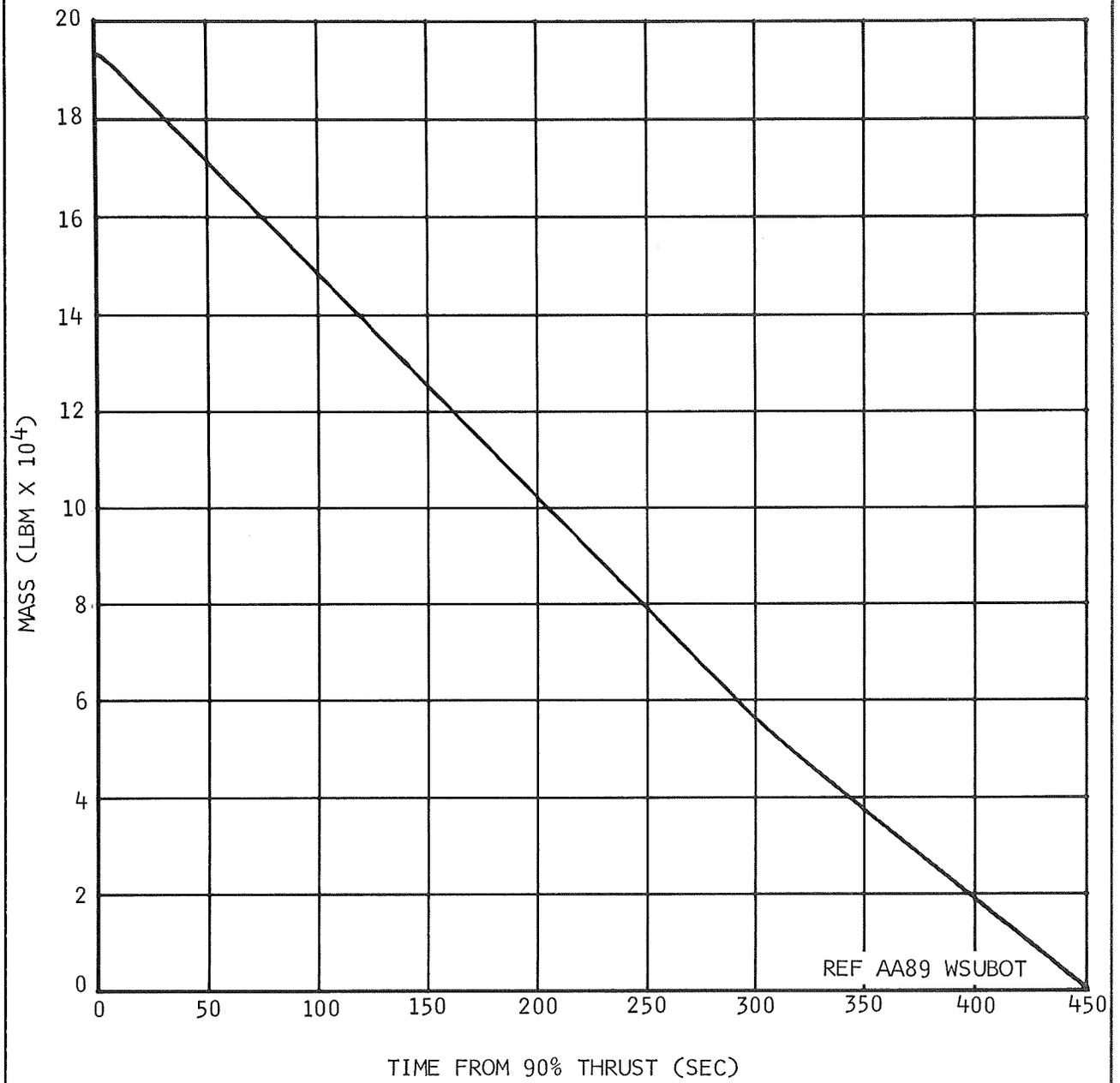


Figure AP 5-17. LOX Mass Onboard

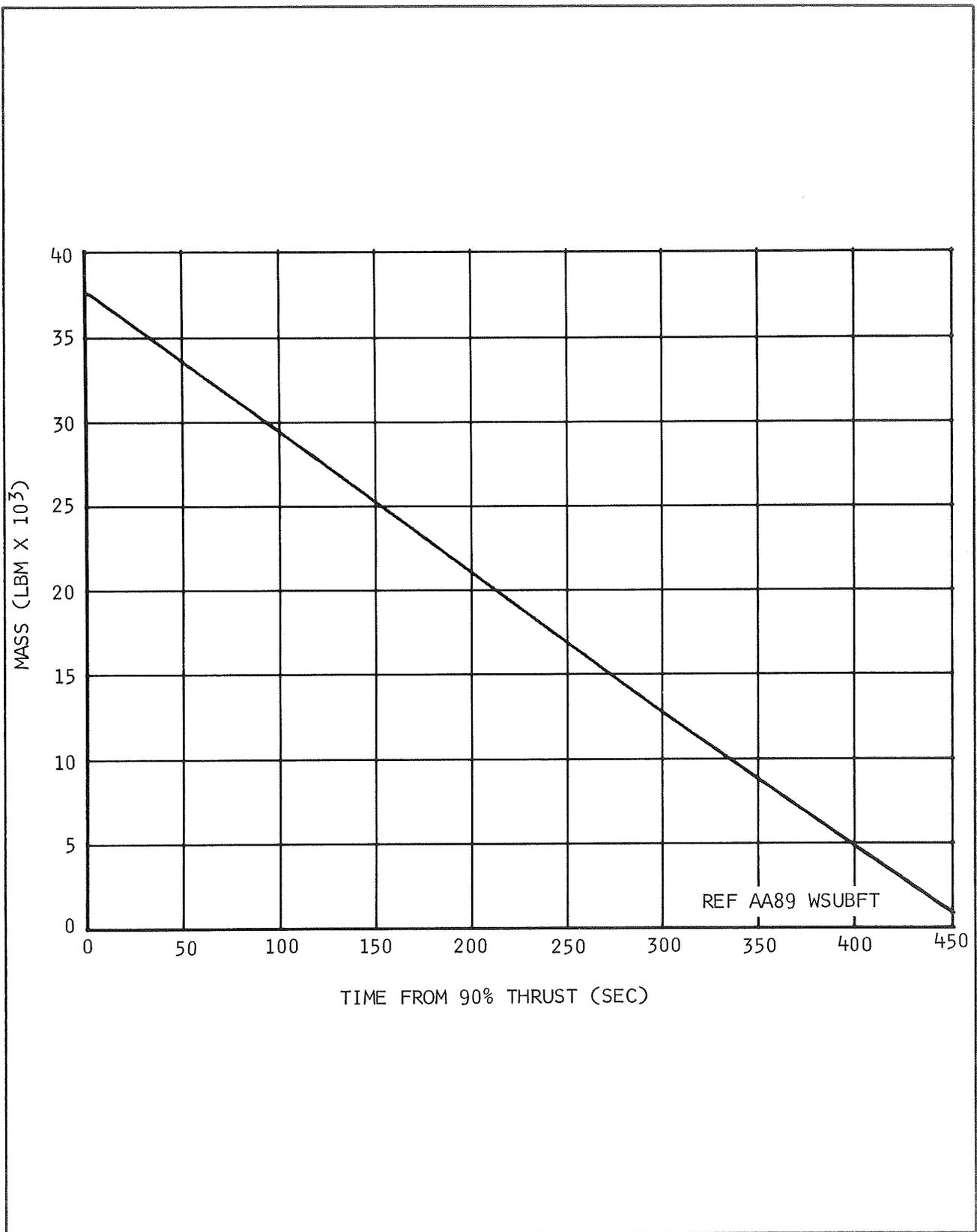


Figure AP 5-18. LH2 Mass Onboard

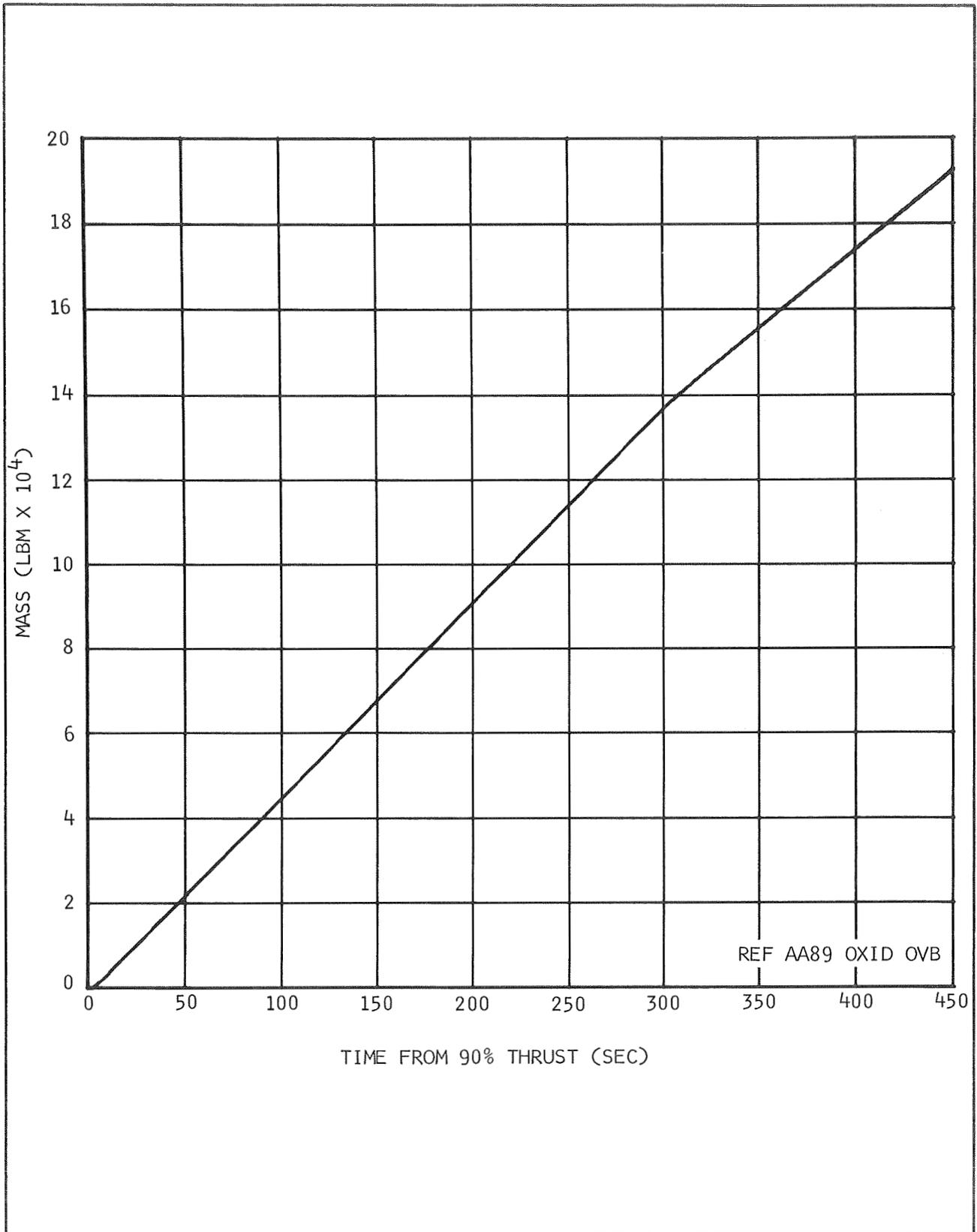


Figure AP 5-19. LOX Mass Overboard

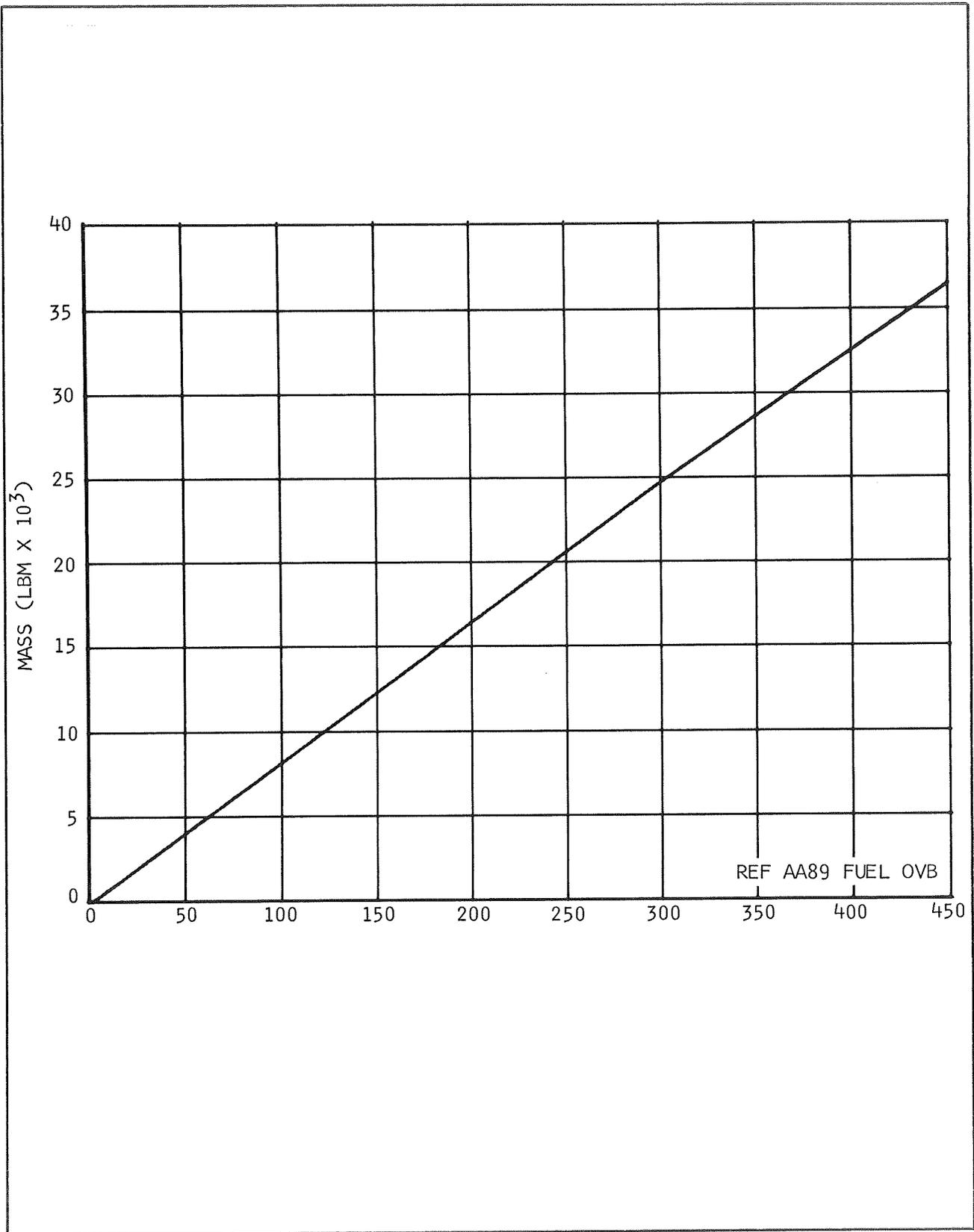


Figure AP 5-20. LH2 Mass Overboard

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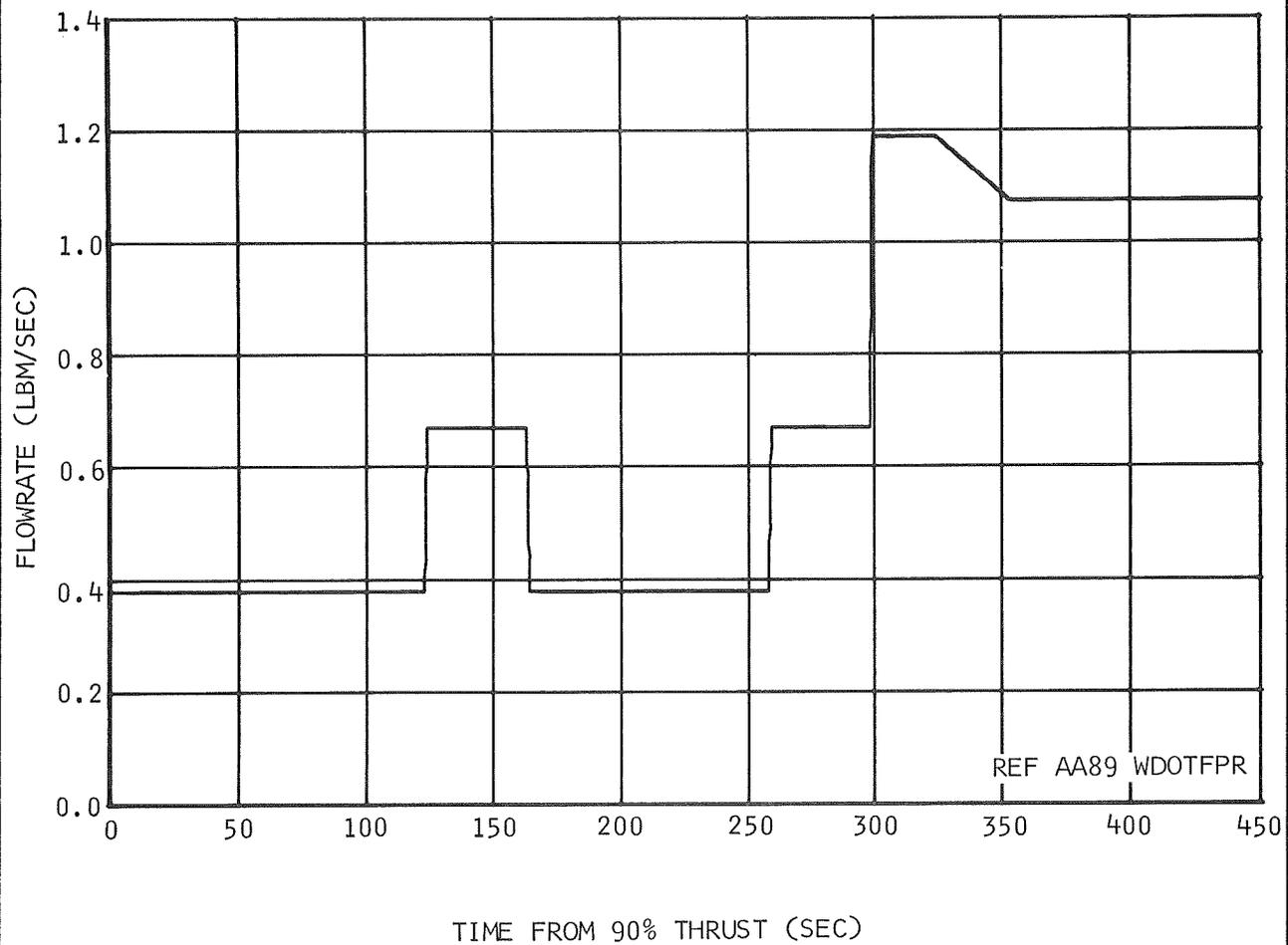


Figure AP 5-21. LH2 Tank GH2 Pressurant Flowrate

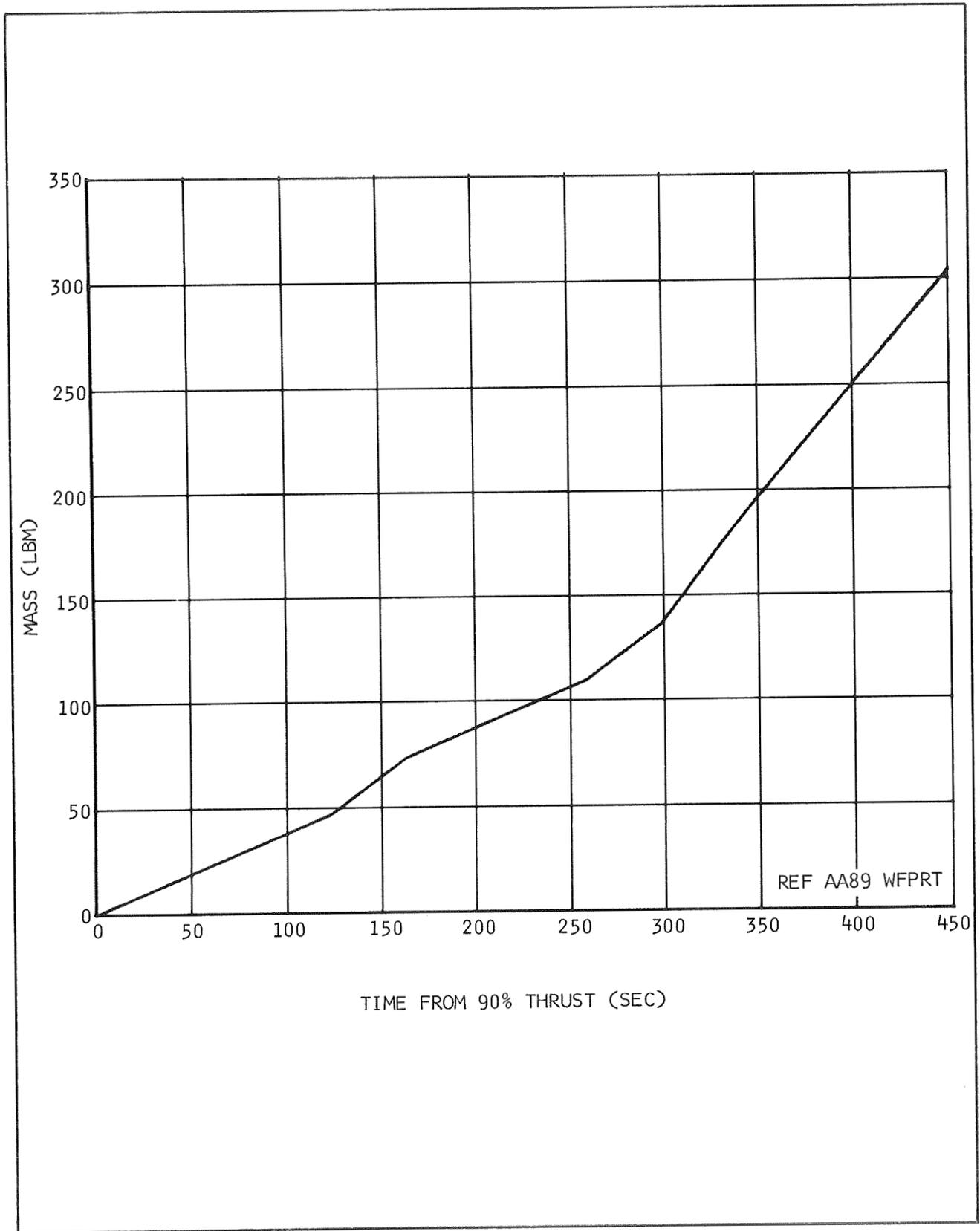


Figure AP 5-22. LH2 Tank Accumulated GH2 Pressurant

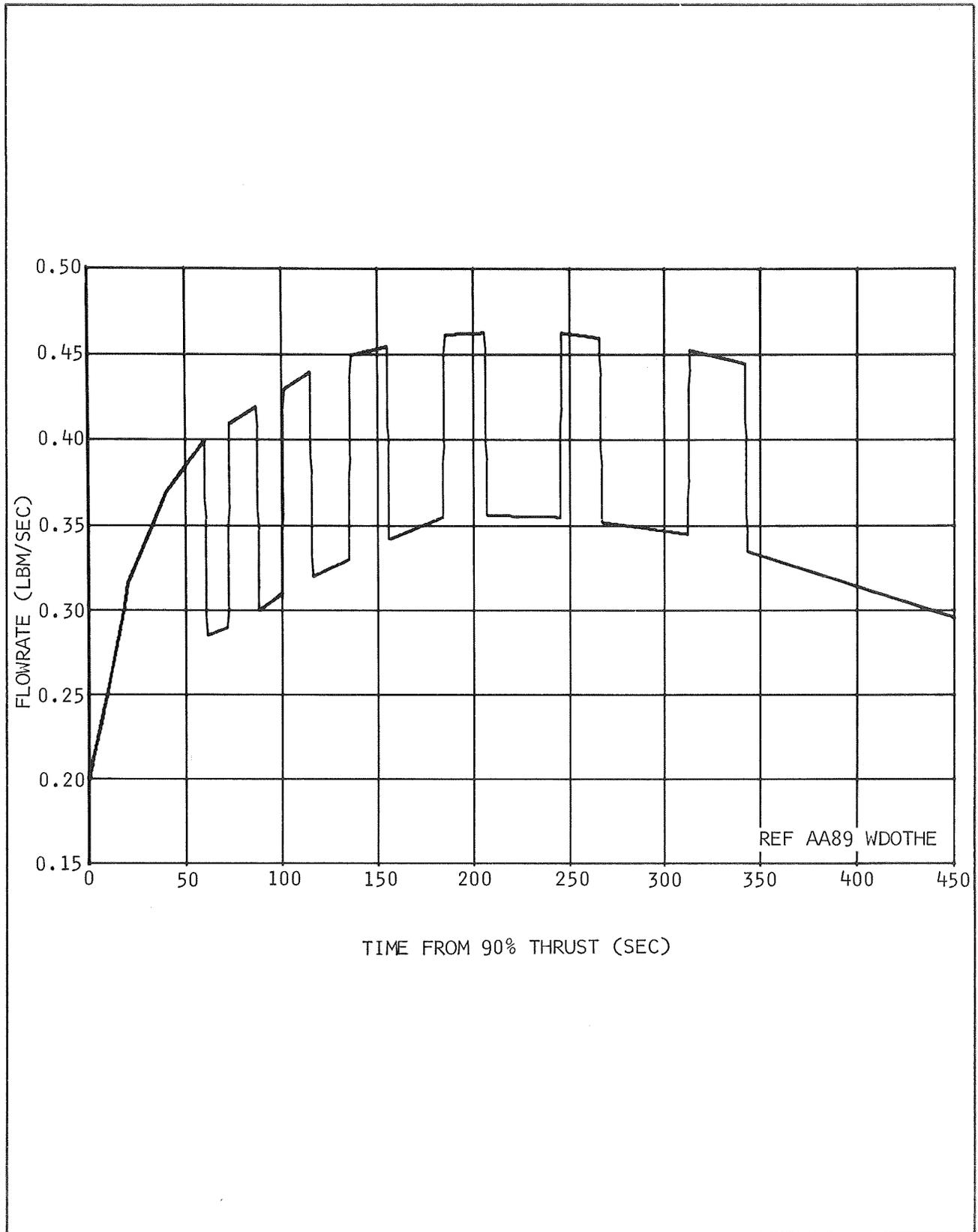


Figure AP 5-23. LOX Tank Helium Pressurant Flowrate

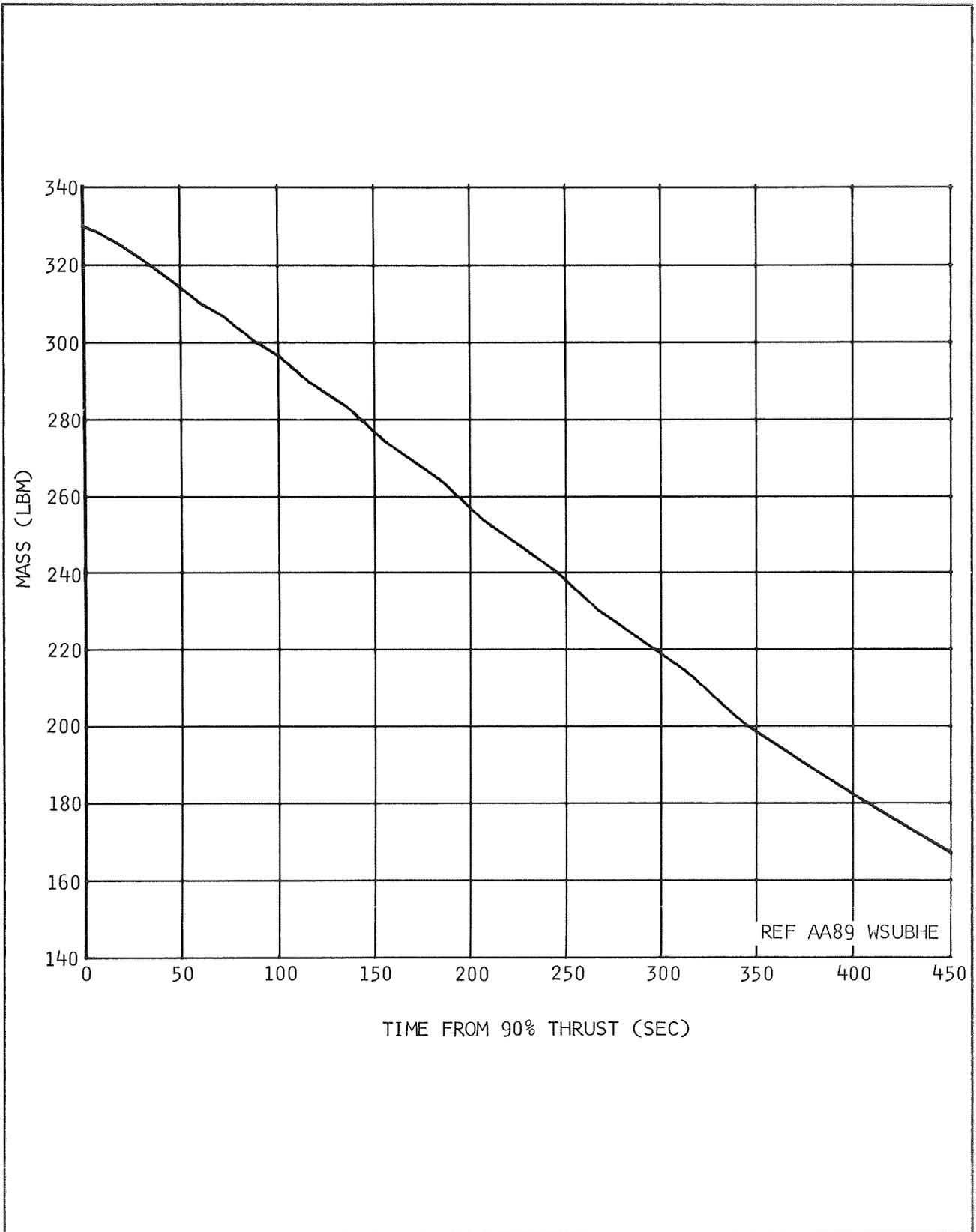


Figure AP 5-24. Mass in Cold Helium Spheres

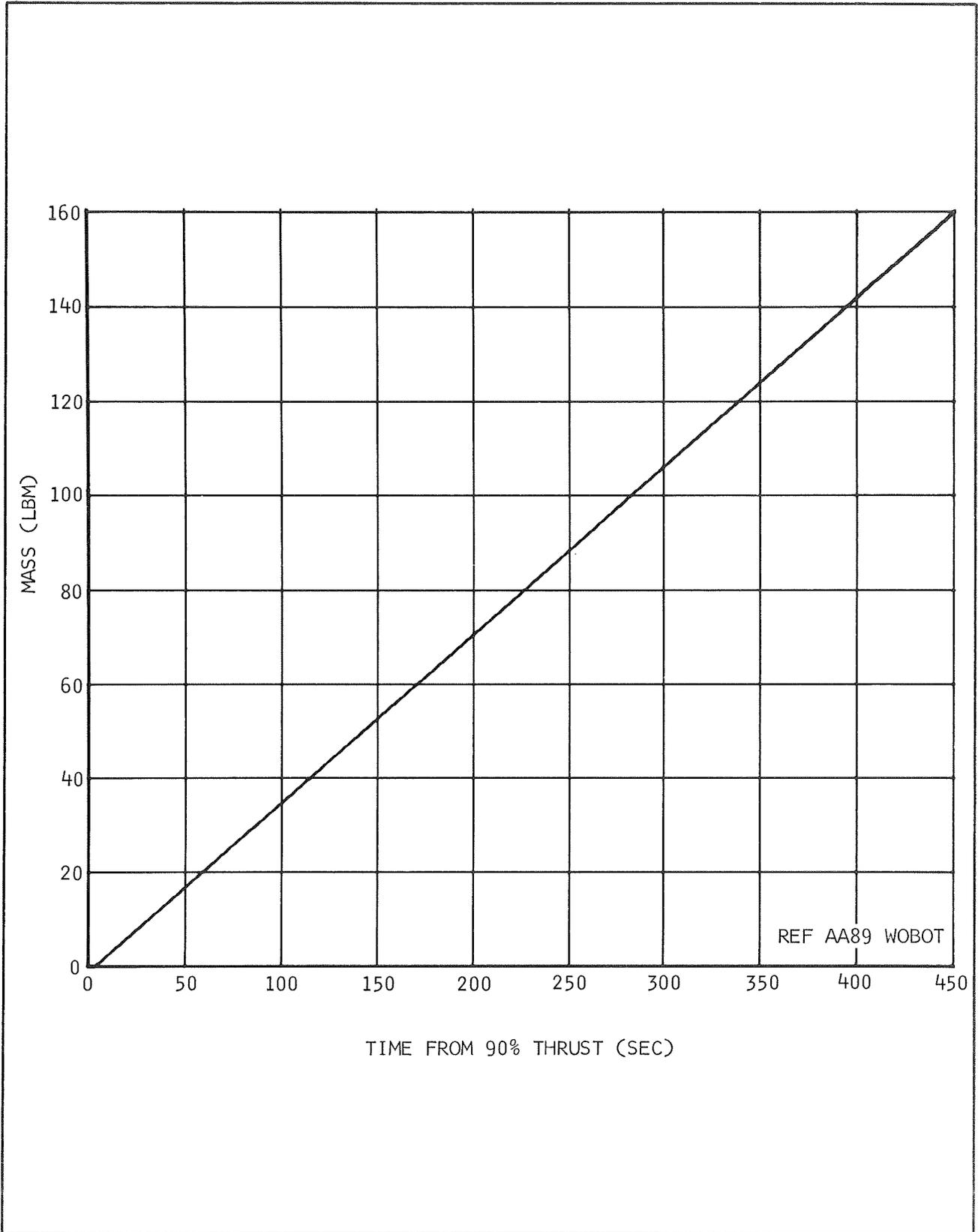


Figure AP 5-25. Total LOX Boiloff

DAC HAS PREDICTED THAT
LH2 BOILOFF WILL BE ZERO
FOR THE S-IVB-206 STAGE

Figure AP 5-26. Total LH2 Boiloff

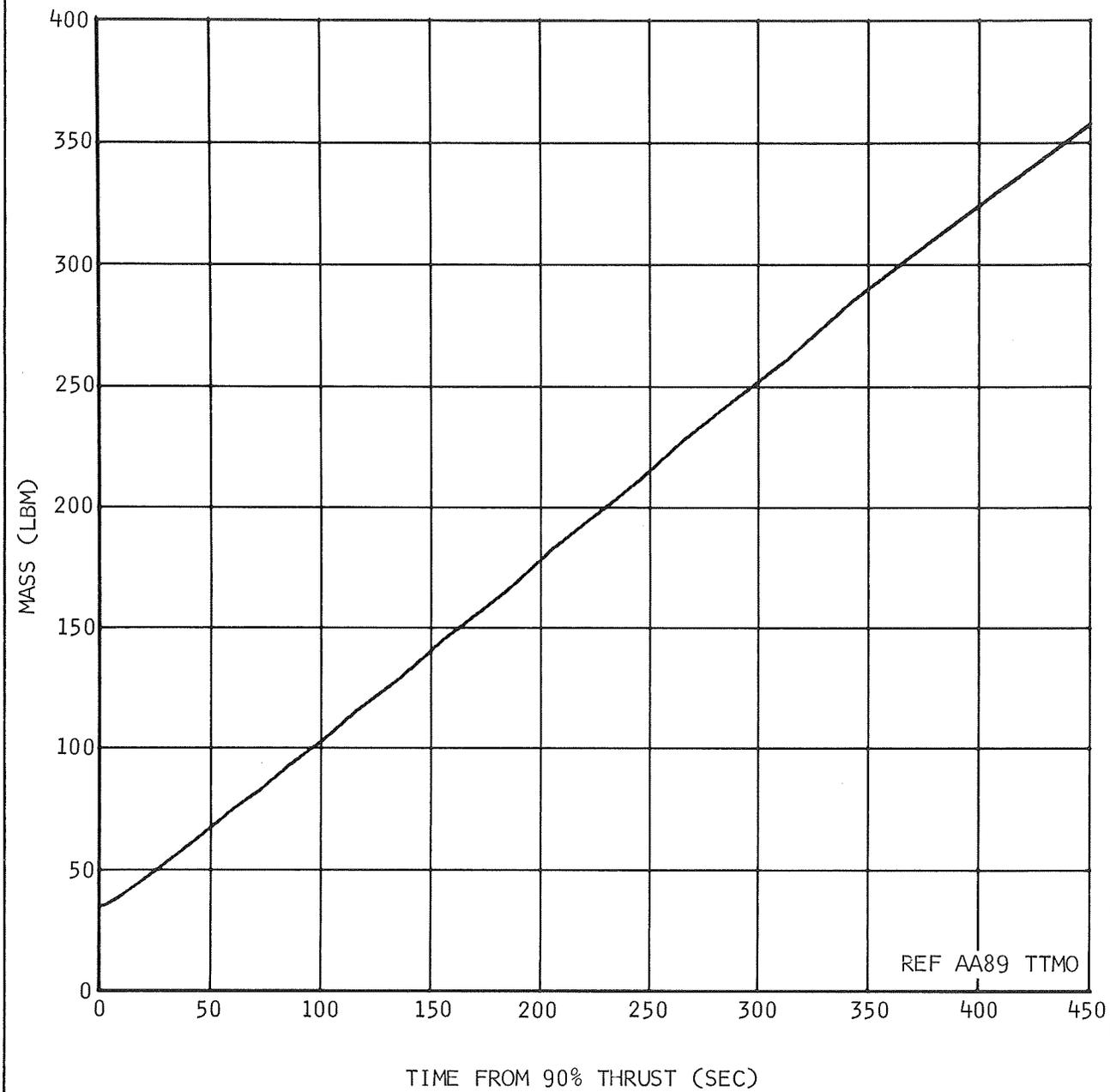


Figure AP 5-27. LOX Tank Ullage Mass

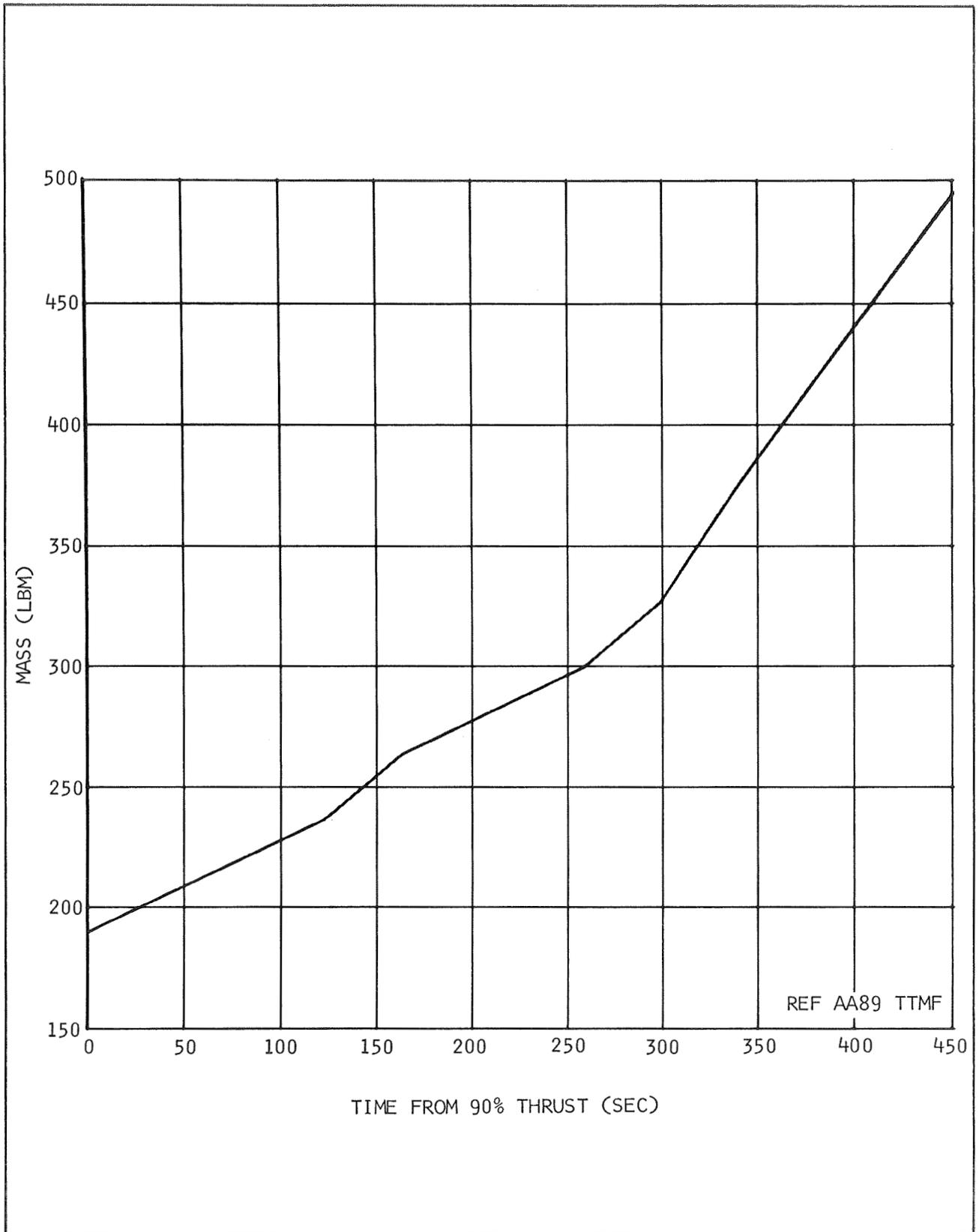


Figure AP 5-28. LH2 Tank Ullage Mass

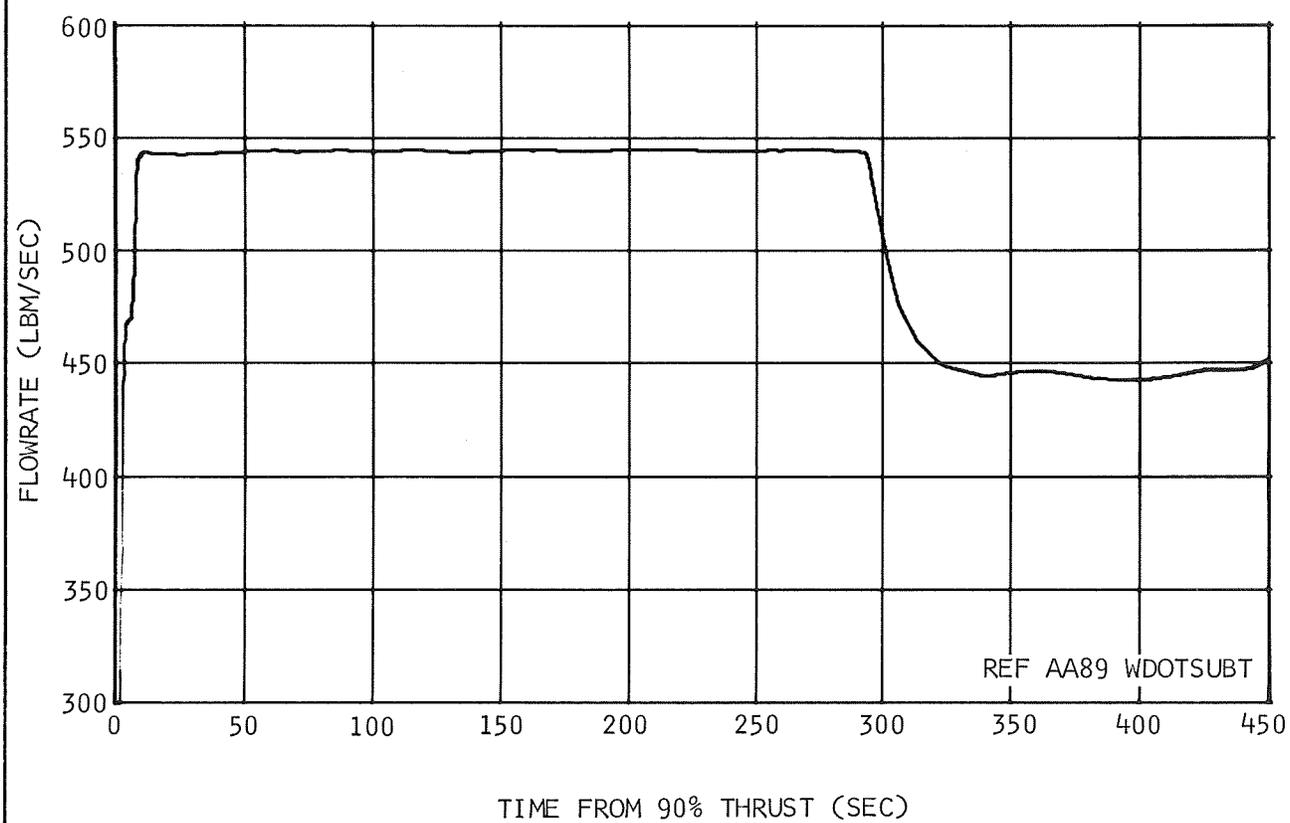


Figure AP 5-29. Engine Propellant Flowrate

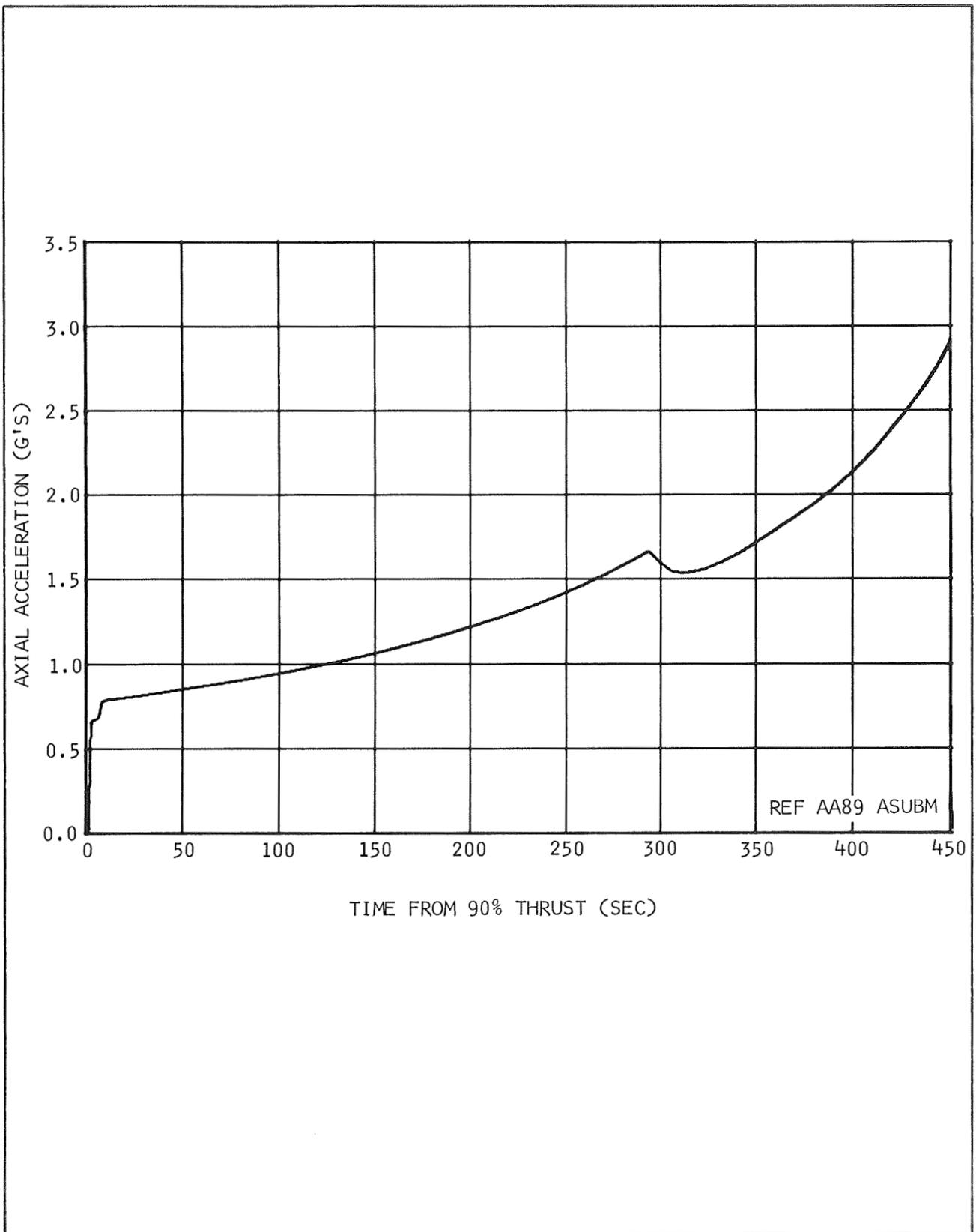


Figure AP 5-30. Axial Acceleration

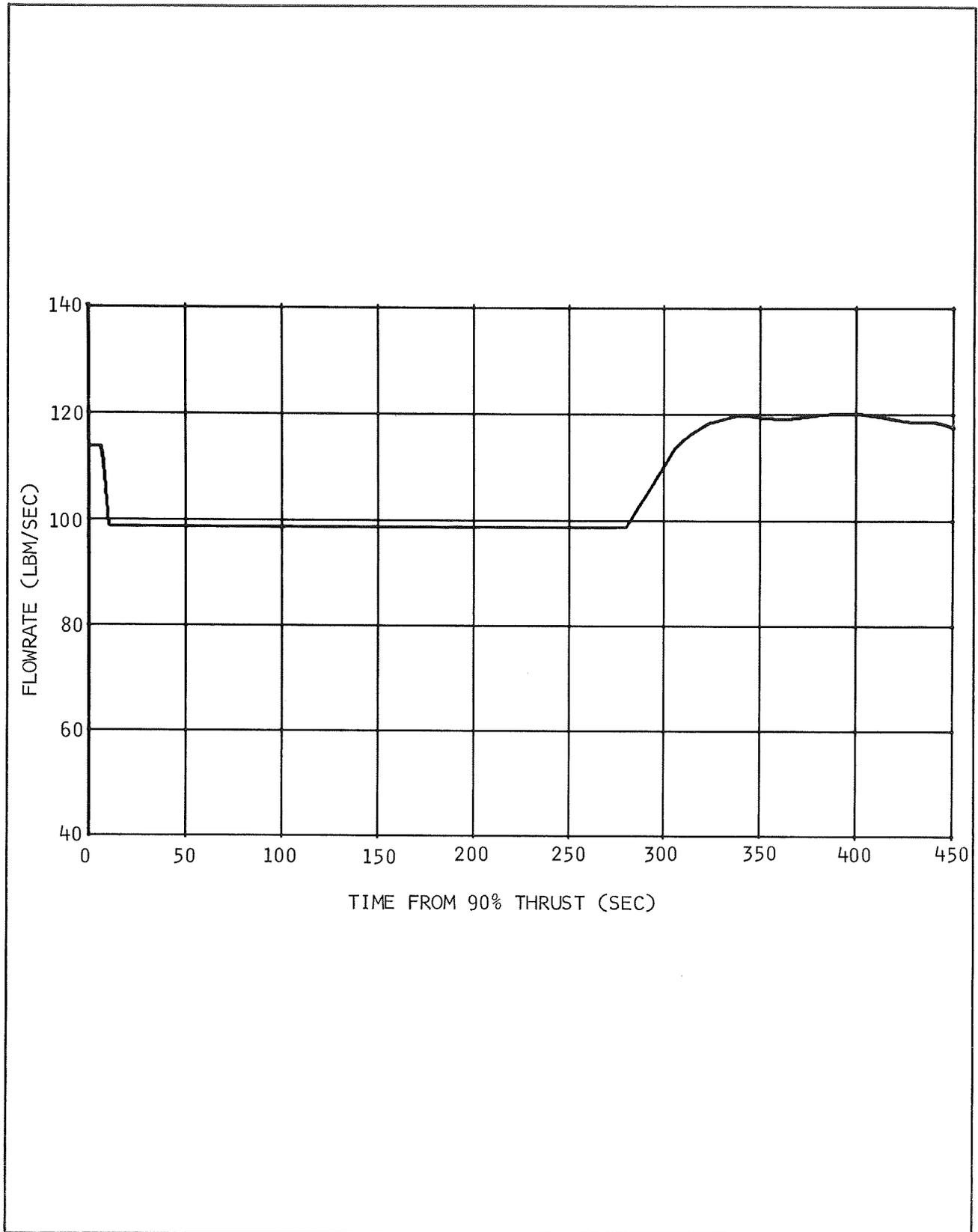


Figure AP 5-31. PU Valve LOX Flowrate

6. PROPELLANT LOADING DATA

The propellant loading requirements for the S-IVB-206 stage, based on the final propulsion predictions presented in appendix 5, are summarized in table AP 6-1.

LOX and LH2 mass sensor calibration data in table AP 6-2 were based on acceptance firing data and previous propellant loading tests at Kennedy Space Center. The mass and capacitance reduction formulae and reference mixture ratio adjustment are shown in table AP 6-3.

The estimated propellant utilization (PU) analysis accuracies for flight and ground loading, as based on the inflight mass characteristics in appendix 2, are presented in table AP 6-4. Tables AP 6-5 and AP 6-6 contain tabulations of the LH2 and LOX tank height versus volume data. These tabulations were based on a nominal tank geometry. The S-IVB-206 stage tank geometry is illustrated in figure AP 6-1.

Predicted LOX and LH2 mass sensor nonlinearities are presented in figures AP 6-2 and AP 6-3 and were based on acceptance firing data.

TABLE AP 6-1 (Sheet 1 of 2)
PRELIMINARY PROPELLANT LOADING REQUIREMENTS SUMMARY*

	LH2 (lbm)		LOX (lbm)	
Usable Propellants				
Total usable propellants (note 1)		36,434		192,227
Nominal propellant consumption (note 2)	Not Available		Not Available	
Available flight performance reserve (note 3)	Not Available		Not Available	
LH2 bias (note 4)	136		-	
Unusable Propellants				
Total unusable propellants		1,202		1,046
Boiloff	20		190	
LH2 tank pressurant (note 5)	306		-	
J-2 start transient (note 6)	116		330	
J-2 cutoff transient (note 7)	27		130	
J-2 trapped (note 8)	10		108	
Unavailable (note 9)	723		288	
Total Desired Load		37,636		193,273

*The allowable KSC loading computer tolerance is ± 0.5 percent of the desired propellant load in each tank. Therefore, by root-sum-square (RSS) of the indicated-to-actual mass accuracy and KSC loading computer tolerance, the desired-to-actual loading accuracy is 1.12 percent of the desired propellant load in each tank, or 422 lbm LH2 and 2,165 lbm LOX.

- NOTES:
1. The propellant load for the AS-206 flight was defined using a nominal burntime to simultaneous propellant depletion of 449.97 sec.
 2. This quantity will normally be burned by the J-2 engine between the 90 percent thrust level at ignition and predicted guidance cutoff.
 3. Nominal flight performance reserve available following a predicted guidance cutoff.
 4. The LH2 bias of 136 lbm is included as a straight line bias to empty and full calibration points to minimize residuals at depletion.

TABLE AP 6-1 (Sheet 2 of 2)
PRELIMINARY PROPELLANT LOADING REQUIREMENTS SUMMARY

NOTES: (Continued)

5. This is required to pressurize the LH2 tank during burn. The LOX tank is pressurized by helium.
6. These are the propellants consumed during the J-2 engine start transient, which is from Engine Start Command to 90 percent thrust.
7. These are the propellants consumed during the J-2 engine cutoff transient, which is from Engine Cutoff Command to zero thrust.
8. These are the propellants trapped in the J-2 engine following the cutoff transient.
9. These are the unavailable propellants trapped in the tanks and lines, based upon depletion sensor cutoff and thrust decay.

TABLE AP 6-2 (Sheet 1 of 2)
S-IVB-206 MASS SENSOR CALIBRATION

LOX MASS SENSOR

Probe No: E-8

Usage: S-IVB-206 flight with transformer on C-IB taps.

LOX LEVEL	CAP (pf)	MASS (lbm)	COARSE RATIO	FINE RATIO (λ)
Helium (Cal. Pt.)	283.11	2,007	0.01833	Tap Plus 0.01796
Air (N ₂ , Cal. Pt.)	283.21	2,154	0.01907	Tap Plus 0.01868
Bottom Inner Element	282.61	1,270	0.01462	Tap Plus 0.01433
Empty Cal. Pt.	282.11	526	0.01088	Tap Plus 0.01066
Full Cal. Pt.	405.35	182,206	0.92347	0.92500
Probe Cal. Pt.	413.22	193,804	0.98173	0.98209
Full Load	412.86	193,273	0.97906	0.97948

NOTES:

1. Empty Cal. (Helium) Ratio = +0.01796; Fine Ratio = 2,007 lbm.
2. Empty Cal. (Nitrogen) Ratio = +0.01868; Fine Ratio = 2,154 lbm.
3. ΔC (Helium) = 122.24 pf = 0.92347; Coarse Ratio = 182,206 lbm.
4. ΔC (Nitrogen) = 122.14 pf = 0.92347; Coarse Ratio = 182,206 lbm.
5. L/C Load to 0.97906 Coarse Ratio = 193,273 lbm (Pressurized).
Maximum acceptable deviation from the nominal load = $\pm 0.5\%$, i.e. 0.97421 and 0.98391. The nominal coarse ratio for the case of tanks pressurized is the value required in the loading computer (L/C) to obtain the desired propellant load.
6. L/C Load to 0.98103 Coarse Ratio = 193,273 lbm (Unpressurized).
An L/C tolerance of $\pm 0.5\%$ about the nominal load yields coarse mass ratios of 0.97618 and 0.98588. The nominal coarse ratio above is to be used as the initial 100 percent value for the KSC propellant loading test. This value is based on propellant loading test data and launch countdown data. Additional adjustments may be required based on information gained during the CDDT.

TABLE AP 6-2 (Sheet 2 of 2)
S-IVB-206 MASS SENSOR CALIBRATION

LH2 MASS SENSOR

Probe No: E-10

Usage: S-IVB-206 flight with transformer on C-IB taps.

LH2 LEVEL	CAP (pf)	MASS (lbm)	COARSE RATIO	FINE RATIO (λ)
Helium (Cal. Pt.)	972.06	75	-0.00958	Tap Minus 0.00939
Air (N ₂ , Cal. Pt.)	972.26	116	-0.00856	Tap Minus 0.00839
Bottom Inner Element	972.70	206	-0.00631	Tap Minus 0.00618
Empty Cal. Pt.	976.06	896	0.01088	Tap Plus 0.01066
Full Cal. Pt	1154.55	37,520	0.92347	0.92500
Probe Cal. Pt.	1151.10	36,813	0.90585	0.90774
Full Load	1155.11	37,636	0.92636	0.92783

NOTES:

1. Empty Cal. (Helium) Ratio = -0.00939; Fine Ratio = 75 lbm.
2. Empty Cal. (Nitrogen) Ratio = -0.00839; Fine Ratio = 116 lbm.
3. ΔC (Helium) = 182.49 pf = 0.92347; Coarse Ratio = 37,520 lbm.
4. ΔC (Nitrogen) = 182.29 pf = 0.92347; Coarse Ratio = 37,520 lbm.
5. L/C Load to 0.92636 Coarse Ratio = 37,636 lbm (Pressurized).
Maximum acceptable deviation from the nominal load = $\pm 0.5\%$, i.e. 0.92167 and 0.93104. The nominal coarse ratio for the case of tanks pressurized is the value required in the loading computer (L/C) to obtain the desired propellant load.
6. L/C Load to 0.92856 Coarse Ratio = 37,636 lbm (Unpressurized).
An L/C tolerance of $\pm 0.5\%$ about the nominal load yields coarse mass ratios of 0.92388 and 0.93324. The nominal coarse ratio above is to be used as the initial 100 percent value for the KSC propellant loading test. This value is based on propellant loading test data and launch countdown data. Additional adjustments may be required based on information gained during the CDDT.

TABLE AP 6-3
MASS AND CAPACITANCE REDUCTION FORMULAE
AND REFERENCE MIXTURE RATIO ADJUSTMENT

MASS AND CAPACITANCE REDUCTION FORMULAE

$$\begin{aligned}\text{LOX Mass} &= \lambda (203,146) - 5,704 \\ \text{LH2 Mass} &= \lambda (40,951) - 360 \\ \text{LOX Capacitance} &= \lambda (137.81) + 277.88 \\ \text{LH2 Capacitance} &= \lambda (199.57) + 969.94\end{aligned}$$

$$\lambda = \frac{\text{LEG}}{20}$$

LEG = Total integral number plus fractional part of fine mass LEGS traversed expressed as a decimal.

Example: LEG = 18.49 indicates that 18 full LEGS have been traversed plus 49/100 of the nineteenth LEG.

REFERENCE MIXTURE RATIO ADJUSTMENT TO 4.7

1. Cal bridges as shown
2. Put in $\Delta C = 182.49$ pf on LH2 Bridge (Helium)
 $\Delta C = 182.29$ pf on LH2 Bridge (Nitrogen)
3. Put in $\Delta C = 117.32$ pf on LOX Bridge (Helium)
 $\Delta C = 117.22$ pf on LOX Bridge (Nitrogen)
4. Adjust summing point to -0.218 Volts.

TABLE AP 6-4 (Sheet 1 of 2)
ESTIMATED PU ANALYSIS ACCURACIES (3 σ Probability)

PREDICTIONS	LEVEL SENSOR NO.		TEST
	LOX (\pm 1bm) L0005	LH2 (\pm 1bm) L0002	
1. Predicted accuracies of the level sensors at the time of level sensor activation 2. Predicted accuracies of the PU mass sensors at the time of level sensor activation 3. Probable deviation between level sensor mass and PU mass sensor mass at the time of level sensor activation (RSS of item 1 with item 2) 4. Predicted accuracy of propellant residuals at ECC as determined by individual level sensor activation 5. Probable deviation between mass sensor and level sensor determined residuals at ECC. (RSS item 4 with item 6) 6. PU System Mass Sensor accuracy of propellant residuals at ECC based on a predicted residual, above the main propellant valves, of 3,141 1bm LOX and 1,494 1bm LH2.	330	49	Flight
	235	42	CDDT*
	390	82	CDDT & Flight
	511	96	Flight
	455	92	CDDT
	337	47	Flight
472	89	Flight	
	LOX (\pm 1bm)	LH2 (\pm 1bm)	TOTAL (\pm 1bm)
	330	75	338

*CDDT (countdown demonstration test) predictions are valid only if propellant is maintained at minimum of 2 deg R below saturation and at nominal tank pressurization.

TABLE AP 6-4 (Sheet 2 of 2)
 ESTIMATED PU ANALYSIS ACCURACIES (3σ Probability)

PREDICTIONS	LOX (+ lbm)	LH2 (+ lbm)	TOTAL (+ lbm)
7. Estimated overall level sensor accuracy of propellant residuals at ECC as determined by the weighted average technique based on predicted residuals of 3,141 lbm LOX and 1,494 lbm LH2 assuming all level sensors activated	337	47	340
8. Combining the estimated level sensor residual accuracy (item 7) with the mass sensor residual accuracy (item 6) using the weighted average technique, the stage estimated residual accuracy at ECC is:	236	40	239
9. The total propellant load as determined after the flight, based on predicted post-flight analysis will be as follows:	FLOW INTEGRAL	PU SYSTEM	FLIGHT SIMULATION
	+0.7%	+0.8%	+0.3%
			WEIGHTED AVERAGE
			+0.261%

TABLE AP 6-5 (Sheet 1 of 3)
 SATURN S-IVB-206 HEIGHT VERSUS VOLUME
 LH2 TANK - GROUND LOADING CONDITION

HEIGHT (IN.)	VOLUME (FT ³)	HEIGHT (IN.)	VOLUME (FT ³)	HEIGHT (IN.)	VOLUME (FT ³)
1.000	0.345	51.000	387.164	101.000	1615.191
2.000	0.461	52.000	402.859	102.000	1645.354
3.000	1.072	53.000	418.927	103.000	1675.517
4.000	2.098	54.000	435.367	104.000	1705.683
5.000	3.480	55.000	452.181	105.000	1735.850
6.000	5.176	56.000	469.369	106.000	1766.020
7.000	7.159	57.000	486.934	107.000	1796.191
8.000	9.411	58.000	504.876	108.000	1826.363
9.000	11.927	59.000	523.199	109.000	1856.538
10.000	14.708	60.000	541.903	110.000	1886.715
11.000	17.758	61.000	560.993	111.000	1916.893
12.000	21.086	62.000	580.470	112.000	1947.074
13.000	24.703	63.000	600.338	113.000	1977.256
14.000	28.620	64.000	620.600	114.000	2007.440
15.000	32.845	65.000	641.260	115.000	2037.626
16.000	37.388	66.000	662.321	116.000	2067.814
17.000	42.253	67.000	683.788	117.000	2098.003
18.000	47.444	68.000	705.665	118.000	2128.195
19.000	52.961	69.000	727.956	119.000	2158.388
20.000	58.799	70.000	750.666	120.000	2188.582
21.000	64.953	71.000	773.799	121.000	2218.778
22.000	71.415	72.000	797.361	122.000	2248.976
23.000	78.173	73.000	821.355	123.000	2279.176
24.000	85.215	74.000	845.787	124.000	2309.376
25.000	92.532	75.000	870.663	125.000	2339.579
26.000	100.112	76.000	895.987	126.000	2369.782
27.000	107.949	77.000	921.764	127.000	2399.987
28.000	116.041	78.000	948.000	128.000	2430.193
29.000	124.392	79.000	974.699	129.000	2460.400
30.000	133.016	80.000	1001.868	130.000	2490.609
31.000	141.939	81.000	1029.510	131.000	2520.818
32.000	151.199	82.000	1057.631	132.000	2551.028
33.000	160.853	83.000	1086.237	133.000	2581.239
34.000	170.977	84.000	1115.331	134.000	2611.451
35.000	181.670	85.000	1144.919	135.000	2641.663
36.000	193.059	86.000	1175.004	136.000	2671.876
37.000	205.302	87.000	1205.592	137.000	2702.090
38.000	218.589	88.000	1236.685	138.000	2732.304
39.000	228.090	89.000	1253.365	139.000	2762.518
40.000	239.243	90.000	1283.510	140.000	2792.732
41.000	250.787	91.000	1313.657	141.000	2822.947
42.000	262.719	92.000	1343.804	142.000	2853.161
43.000	275.036	93.000	1373.953	143.000	2883.375
44.000	287.735	94.000	1404.102	144.000	2913.589
45.000	300.814	95.000	1434.254	145.000	2943.803
46.000	314.271	96.000	1464.406	146.000	2974.016
47.000	328.103	97.000	1494.560	147.000	3004.229
48.000	342.309	98.000	1524.715	148.000	3034.441
49.000	356.888	99.000	1554.872	149.000	3064.652
50.000	371.840	100.000	1585.031	150.000	3094.862

TABLE AP 6-5 (Sheet 2 of 3)
 SATURN S-IVB-206 HEIGHT VERSUS VOLUME
 LH2 TANK - GROUND LOADING CONDITION

HEIGHT (IN.)	VOLUME (FT ³)	HEIGHT (IN.)	VOLUME (FT ³)	HEIGHT (IN.)	VOLUME (FT ³)
151.000	3125.071	201.000	4631.847	251.000	6127.906
152.000	3155.279	202.000	4661.872	252.000	6157.766
153.000	3185.486	203.000	4691.891	253.000	6187.626
154.000	3215.692	204.000	4721.906	254.000	6217.487
155.000	3245.896	205.000	4751.915	255.000	6247.348
156.000	3276.098	206.000	4781.919	256.000	6277.210
157.000	3306.298	207.000	4811.918	257.000	6307.073
158.000	3336.497	208.000	4841.912	258.000	6336.937
159.000	3366.694	209.000	4871.901	259.000	6366.803
160.000	3396.889	210.000	4901.885	260.000	6396.670
161.000	3427.081	211.000	4931.864	261.000	6426.539
162.000	3457.272	212.000	4961.838	262.000	6456.410
163.000	3487.460	213.000	4991.807	263.000	6486.283
164.000	3517.645	214.000	5021.771	264.000	6516.158
165.000	3547.828	215.000	5051.730	265.000	6546.035
166.000	3578.007	216.000	5081.685	266.000	6575.916
167.000	3608.185	217.000	5111.635	267.000	6605.799
168.000	3638.359	218.000	5141.581	268.000	6635.685
169.000	3668.530	219.000	5171.522	269.000	6665.574
170.000	3698.697	220.000	5201.458	270.000	6695.466
171.000	3728.862	221.000	5231.390	271.000	6725.362
172.000	3759.023	222.000	5261.318	272.000	6755.261
173.000	3789.181	223.000	5291.242	273.000	6785.164
174.000	3819.335	224.000	5321.161	274.000	6815.071
175.000	3849.485	225.000	5351.077	275.000	6844.982
176.000	3879.632	226.000	5380.989	276.000	6874.897
177.000	3909.774	227.000	5410.896	277.000	6904.816
178.000	3939.913	228.000	5440.801	278.000	6934.740
179.000	3970.048	229.000	5470.702	279.000	6964.668
180.000	4000.178	230.000	5500.599	280.000	6994.601
181.000	4030.305	231.000	5530.493	281.000	7024.538
182.000	4060.427	232.000	5560.383	282.000	7054.480
183.000	4090.544	233.000	5590.271	283.000	7084.427
184.000	4120.657	234.000	5620.156	284.000	7114.379
185.000	4150.766	235.000	5650.039	285.000	7144.336
186.000	4180.870	236.000	5679.918	286.000	7174.297
187.000	4210.970	237.000	5709.795	287.000	7204.264
188.000	4241.064	238.000	5739.670	288.000	7234.235
189.000	4271.154	239.000	5769.543	289.000	7264.212
190.000	4301.240	240.000	5799.413	290.000	7294.194
191.000	4331.320	241.000	5829.282	291.000	7324.180
192.000	4361.395	242.000	5859.149	292.000	7354.172
193.000	4391.466	243.000	5889.015	293.000	7384.169
194.000	4421.531	244.000	5918.879	294.000	7414.170
195.000	4451.592	245.000	5948.742	295.000	7444.177
196.000	4481.647	246.000	5978.604	296.000	7474.188
197.000	4511.697	247.000	6008.466	297.000	7504.203
198.000	4541.742	248.000	6038.326	298.000	7534.223
199.000	4571.783	249.000	6068.186	299.000	7564.248
200.000	4601.817	250.000	6098.046	300.000	7594.276

TABLE AP 6-5 (Sheet 3 of 3)
 SATURN S-IVB-206 HEIGHT VERSUS VOLUME
 LH2 TANK - GROUND LOADING CONDITION

HEIGHT (IN.)	VOLUME (FT ³)	HEIGHT (IN.)	VOLUME (FT ³)	HEIGHT (IN.)	VOLUME (FT ³)
301.000	7624.309	347.000	8985.311	392.000	10023.915
302.000	7654.345	348.000	9012.696	393.000	10041.265
303.000	7684.385	349.000	9039.934	394.000	10058.307
304.000	7714.428	350.000	9067.021	395.000	10075.035
305.000	7744.475	351.000	9093.953	396.000	10091.447
306.000	7774.524	352.000	9120.728	397.000	10107.537
307.000	7804.576	353.000	9147.342	398.000	10123.302
308.000	7834.630	354.000	9173.792	399.000	10138.738
309.000	7863.552	355.000	9200.075	400.000	10153.840
310.000	7894.462	356.000	9226.188	401.000	10168.604
311.000	7925.328	357.000	9252.128	402.000	10183.025
312.000	7956.147	358.000	9277.891	403.000	10197.100
313.000	7986.916	359.000	9303.474	404.000	10210.825
314.000	8017.633	360.000	9328.873	405.000	10224.194
315.000	8048.295	361.000	9354.086	406.000	10237.204
316.000	8078.901	362.000	9379.109	407.000	10249.850
317.000	8109.448	363.000	9403.938	408.000	10262.128
318.000	8139.933	364.000	9428.571	409.000	10274.033
319.000	8170.353	365.000	9453.003	410.000	10285.561
320.000	8200.707	366.000	9477.232	411.000	10296.708
321.000	8230.991	367.000	9501.253	412.000	10307.469
322.000	8261.204	368.000	9525.064	413.000	10317.839
323.000	8291.342	369.000	9548.661	414.000	10327.814
324.000	8321.403	370.000	9572.041	415.000	10337.389
325.000	8351.385	371.000	9595.199	416.000	10346.561
326.000	8381.284	372.000	9618.132	417.000	10355.323
327.000	8411.099	373.000	9640.837	418.000	10363.672
328.000	8440.825	374.000	9663.310	419.000	10371.603
329.000	8470.462	375.000	9685.548	420.000	10379.111
330.000	8500.006	376.000	9707.546	421.000	10386.192
331.000	8529.453	377.000	9729.302	422.000	10392.840
332.000	8558.803	378.000	9750.810	423.000	10399.052
333.000	8588.052	379.000	9772.069	424.000	10404.821
334.000	8617.196	380.000	9793.073	425.000	10410.145
335.000	8646.234	381.000	9813.820	426.000	10415.016
336.000	8675.161	382.000	9834.305	427.000	10419.432
337.000	8703.977	383.000	9854.524	428.000	10423.386
338.000	8732.677	384.000	9874.474	429.000	10426.874
339.000	8761.260	385.000	9894.152	430.000	10429.892
340.000	8789.721	386.000	9913.552	431.000	10432.433
341.000	8818.058	387.000	9932.671	432.000	10434.493
342.000	8846.268	388.000	9951.505	433.000	10436.068
343.000	8874.348	389.000	9970.051	434.000	10437.151
344.000	8902.296	390.000	9988.304	435.000	10437.739
345.000	8930.107	391.000	10006.259	436.000	10437.825
346.000	8957.780				

TABLE AP 6-6 (Sheet 1 of 2)
 SATURN S-IVB-206 HEIGHT VERSUS VOLUME
 LOX TANK - GROUND LOADING CONDITION

HEIGHT (IN.)	VOLUME (FT ³)	HEIGHT (IN.)	VOLUME (FT ³)	HEIGHT (IN.)	VOLUME (FT ³)
1.000	0.251	51.000	532.635	101.000	1750.906
2.000	1.002	52.000	552.044	102.000	1775.915
3.000	2.210	53.000	571.735	103.000	1800.723
4.000	3.872	54.000	591.702	104.000	1825.327
5.000	5.986	55.000	611.943	105.000	1849.722
6.000	8.550	56.000	632.454	106.000	1873.906
7.000	11.561	57.000	653.232	107.000	1897.874
8.000	15.014	58.000	674.272	108.000	1921.623
9.000	18.909	59.000	695.571	109.000	1945.149
10.000	23.241	60.000	717.126	110.000	1968.449
11.000	28.006	61.000	738.933	111.000	1991.519
12.000	33.203	62.000	760.987	112.000	2014.356
13.000	38.826	63.000	783.287	113.000	2036.955
14.000	44.873	64.000	805.826	114.000	2059.314
15.000	51.341	65.000	828.603	115.000	2081.427
16.000	58.225	66.000	851.614	116.000	2103.293
17.000	65.521	67.000	874.853	117.000	2124.908
18.000	73.227	68.000	898.319	118.000	2146.267
19.000	81.339	69.000	922.007	119.000	2167.366
20.000	89.852	70.000	945.913	120.000	2188.204
21.000	98.763	71.000	970.034	121.000	2208.775
22.000	108.068	72.000	994.366	122.000	2229.076
23.000	117.764	73.000	1018.905	123.000	2249.104
24.000	127.846	74.000	1043.647	124.000	2268.855
25.000	138.312	75.000	1068.590	125.000	2288.325
26.000	149.156	76.000	1093.729	126.000	2307.511
27.000	160.376	77.000	1119.060	127.000	2326.408
28.000	171.967	78.000	1144.581	128.000	2345.015
29.000	183.926	79.000	1170.287	129.000	2363.326
30.000	196.249	80.000	1196.176	130.000	2381.338
31.000	208.932	81.000	1222.243	131.000	2399.047
32.000	221.972	82.000	1248.486	132.000	2416.451
33.000	235.365	83.000	1274.901	133.000	2433.545
34.000	249.107	84.000	1301.485	134.000	2450.325
35.000	263.195	85.000	1328.235	135.000	2466.789
36.000	377.625	86.000	1355.148	136.000	2482.932
37.000	292.392	87.000	1382.222	137.000	2498.751
38.000	307.495	88.000	1409.453	138.000	2514.241
39.000	322.928	89.000	1436.444	139.000	2529.401
40.000	338.689	90.000	1463.582	140.000	2544.225
41.000	354.773	91.000	1490.562	141.000	2558.711
42.000	371.178	92.000	1517.381	142.000	2572.854
43.000	387.899	93.000	1544.035	143.000	2586.651
44.000	404.933	94.000	1570.521	144.000	2600.099
45.000	422.276	95.000	1596.835	145.000	2613.193
46.000	439.926	96.000	1622.974	146.000	2625.931
47.000	457.877	97.000	1648.933	147.000	2638.308
48.000	476.128	98.000	1674.710	148.000	2650.321
49.000	494.673	99.000	1700.300	149.000	2661.966
50.000	513.510	100.000	1725.700	150.000	2673.240

TABLE AP 6-6 (Sheet 2 of 2)
 SATURN S-IVB-206 HEIGHT VERSUS VOLUME
 LOX TANK - GROUND LOADING CONDITION

HEIGHT (IN.)	VOLUME (FT ³)	HEIGHT (IN.)	VOLUME (FT ³)	HEIGHT (IN.)	VOLUME (FT ³)
151.000	2684.139	160.000	2764.756	169.000	2812.063
152.000	2694.659	161.000	2771.706	170.000	2815.149
153.000	2704.797	162.000	2778.241	171.000	2817.786
154.000	2714.549	163.000	2784.357	172.000	2819.973
155.000	2723.912	164.000	2790.051	173.000	2821.705
156.000	2732.882	165.000	2795.320	174.000	2822.978
157.000	2741.455	166.000	2800.159	175.000	2823.790
158.000	2749.627	167.000	2804.565	176.000	2824.136
159.000	2757.396	168.000	2808.534		

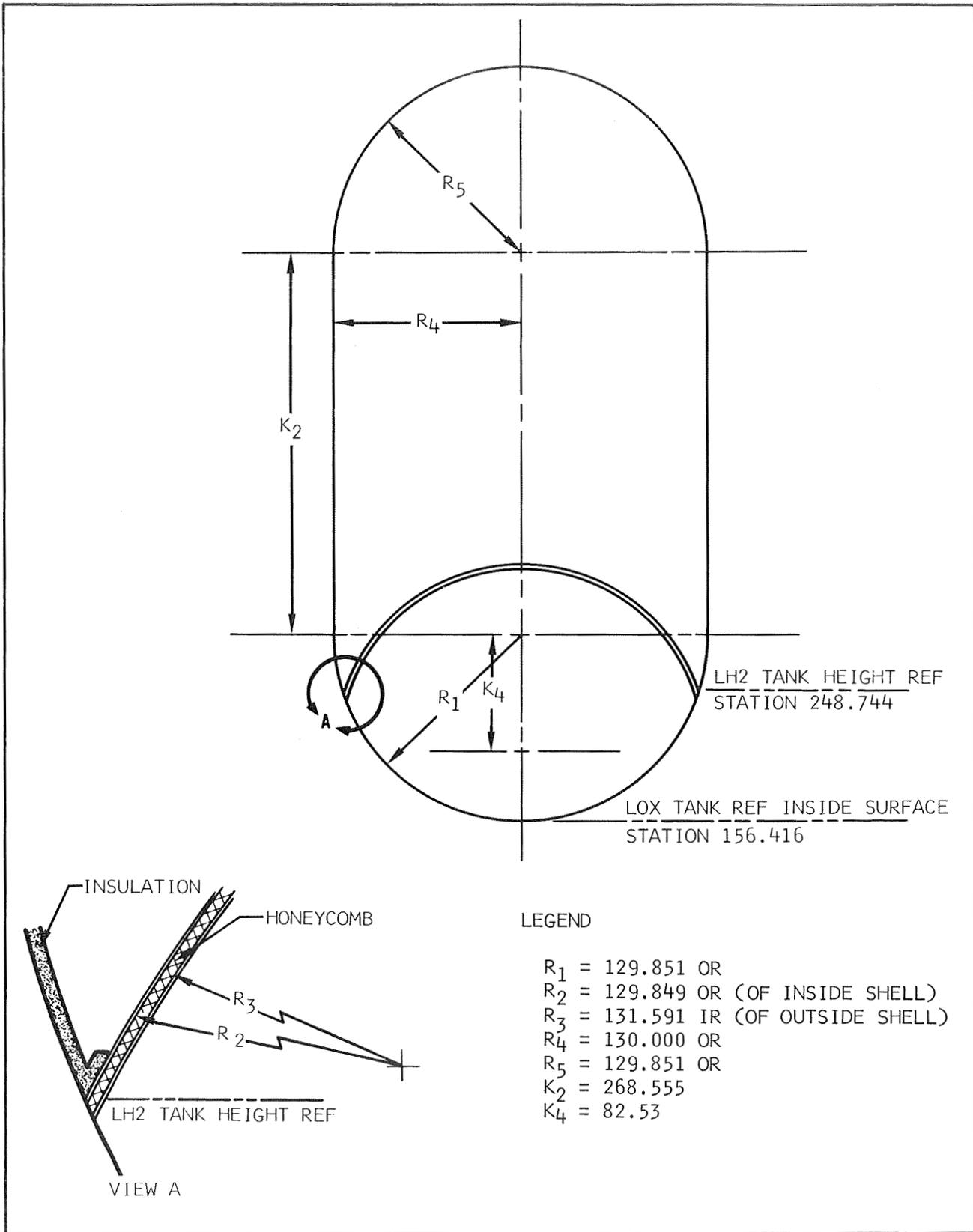


Figure AP 6-1. Propellant Tank Geometry



Figure AP 6-2. Total LH2 Nonlinearity

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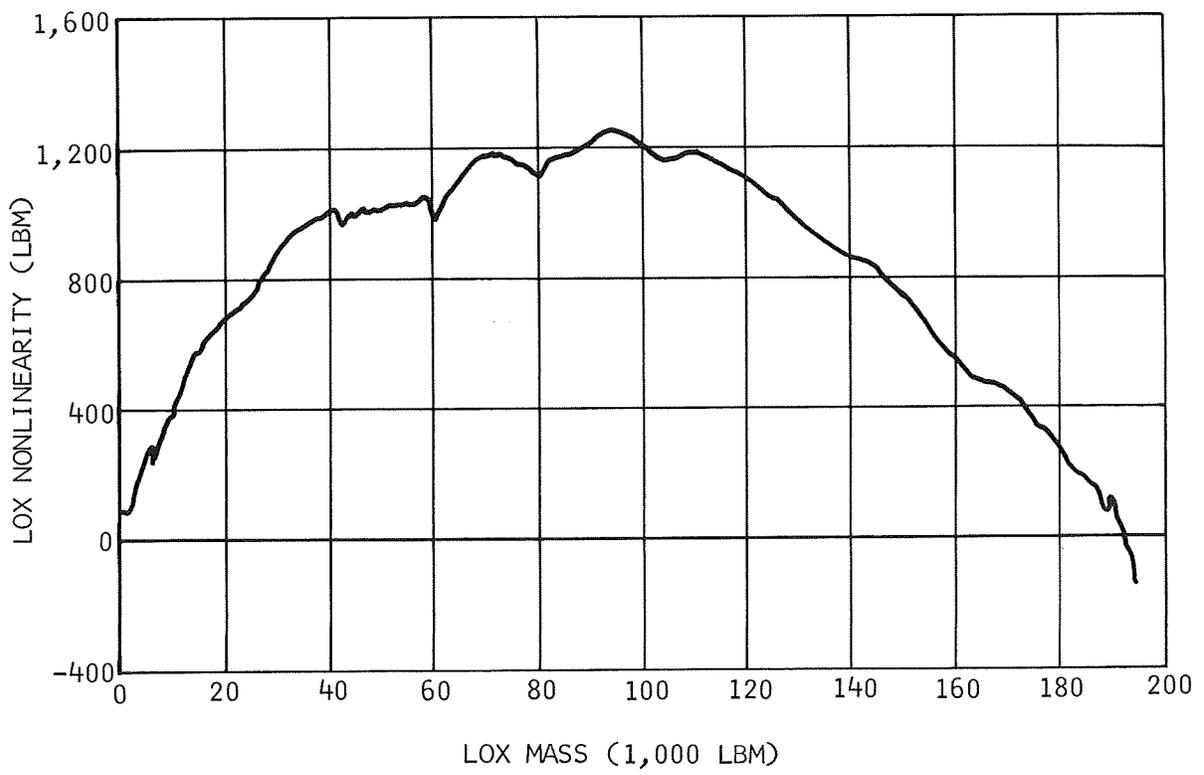


Figure AP 6-3. Total LOX Nonlinearity



7. PREDICTED SEPARATION AND CONTROL PERFORMANCE

7.1 General

This appendix contains predicted stage separation, preflight control transient simulations, and control performance curves (figures AP 7-1 through AP 7-7).

Nominal relative motion and predicted separation history between the S-IB and the S-IVB stages (figures AP 7-6 and AP 7-7) were derived by using S-IB/S-IVB separation analysis for AS-206 and presented to MSFC in the DAC letter A3-860-KACA-4.43.9-L-2691 (reference 15) dated 21 September 1966. The S-IB/S-IVB separation sequence will be initiated 0.5 sec later than on AS-201 through AS-203.

7.2 Predicted Preflight Control Transient Simulation

Body attitude transients of varying magnitude are expected following S-IB/S-IVB separation, active guidance initiation and introduction of chi tilde ($\tilde{\chi}$) guidance mode. The nominal transients expected during these periods of flight will be simulated and graphs of the resulting attitude errors, APS firings, and engine deflections will be included in a revision to this document. The simulation program solves the vehicle equations of motion for three rotational degrees of freedom. The equations of motion include the main engine control system equations (with servo-loop nonlinearities), roll control system equations ST-124M stable platform equations (with transport delays), and the equations representing aerodynamic forces, propellant sloshing forces, and ullage rocket and main engine thrust vector misalignment.

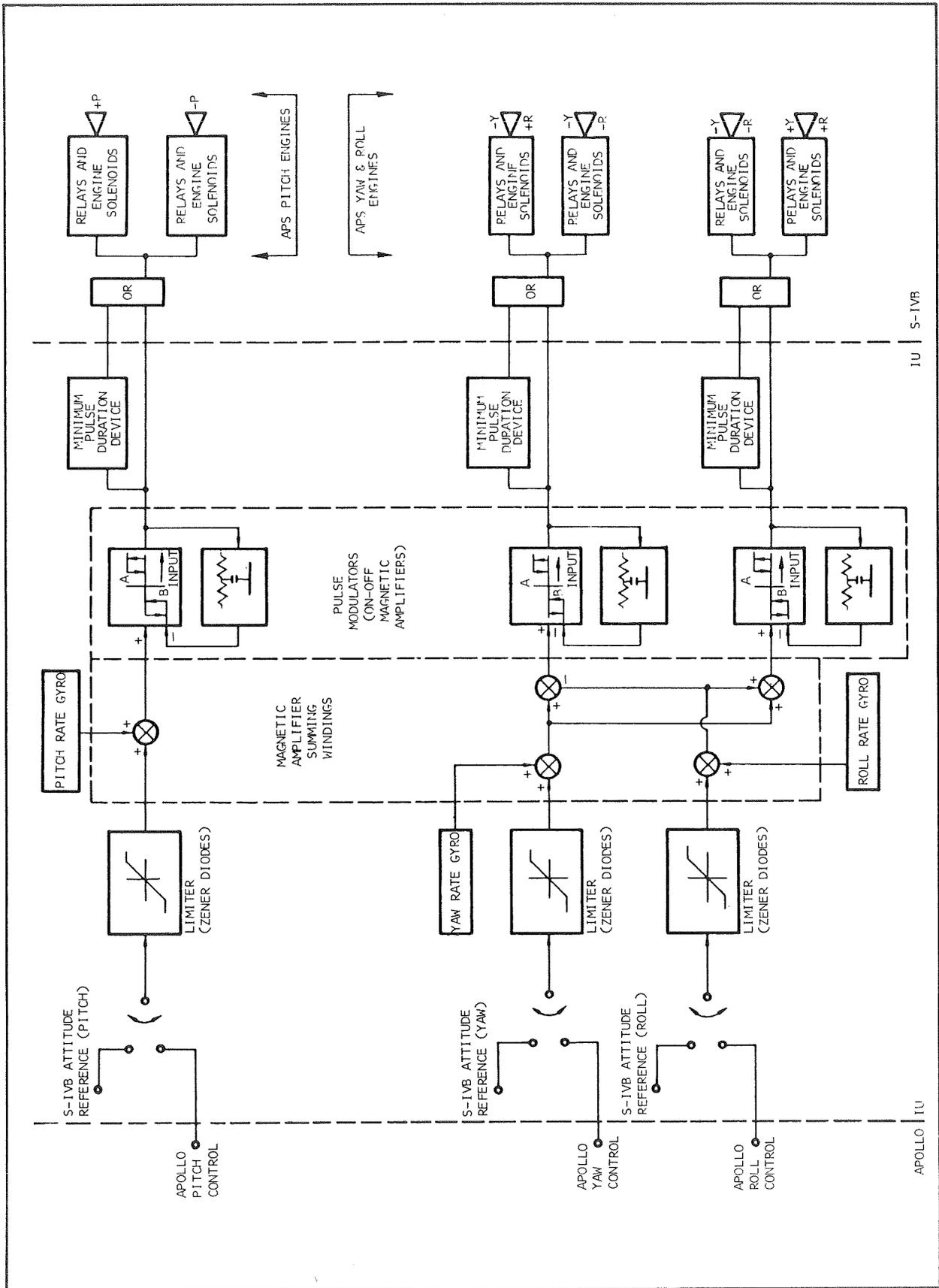


Figure AP 7-2. S-IVB-206 Auxiliary Attitude Control System

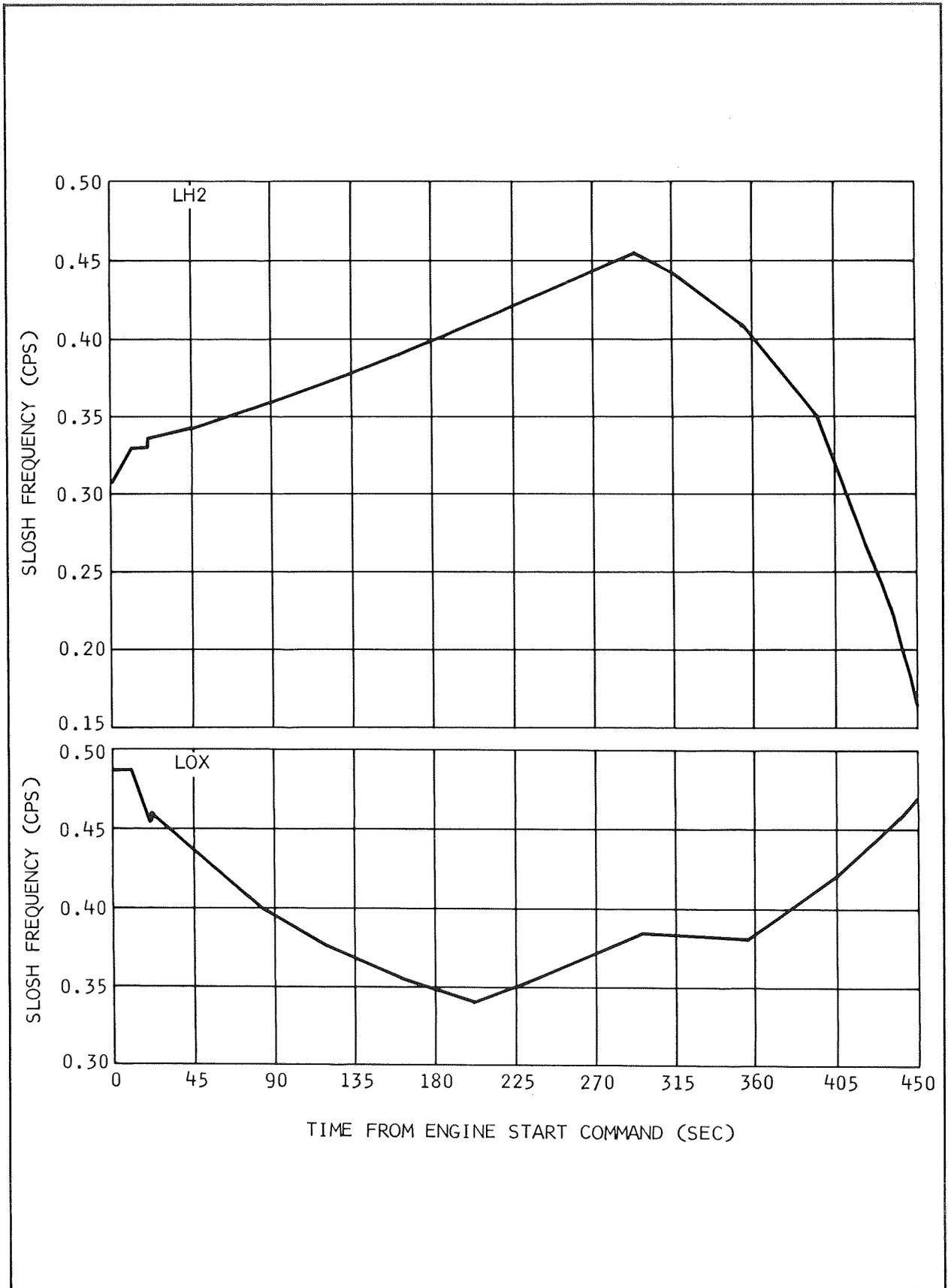


Figure AP 7-3. Propellant Slosh Frequency

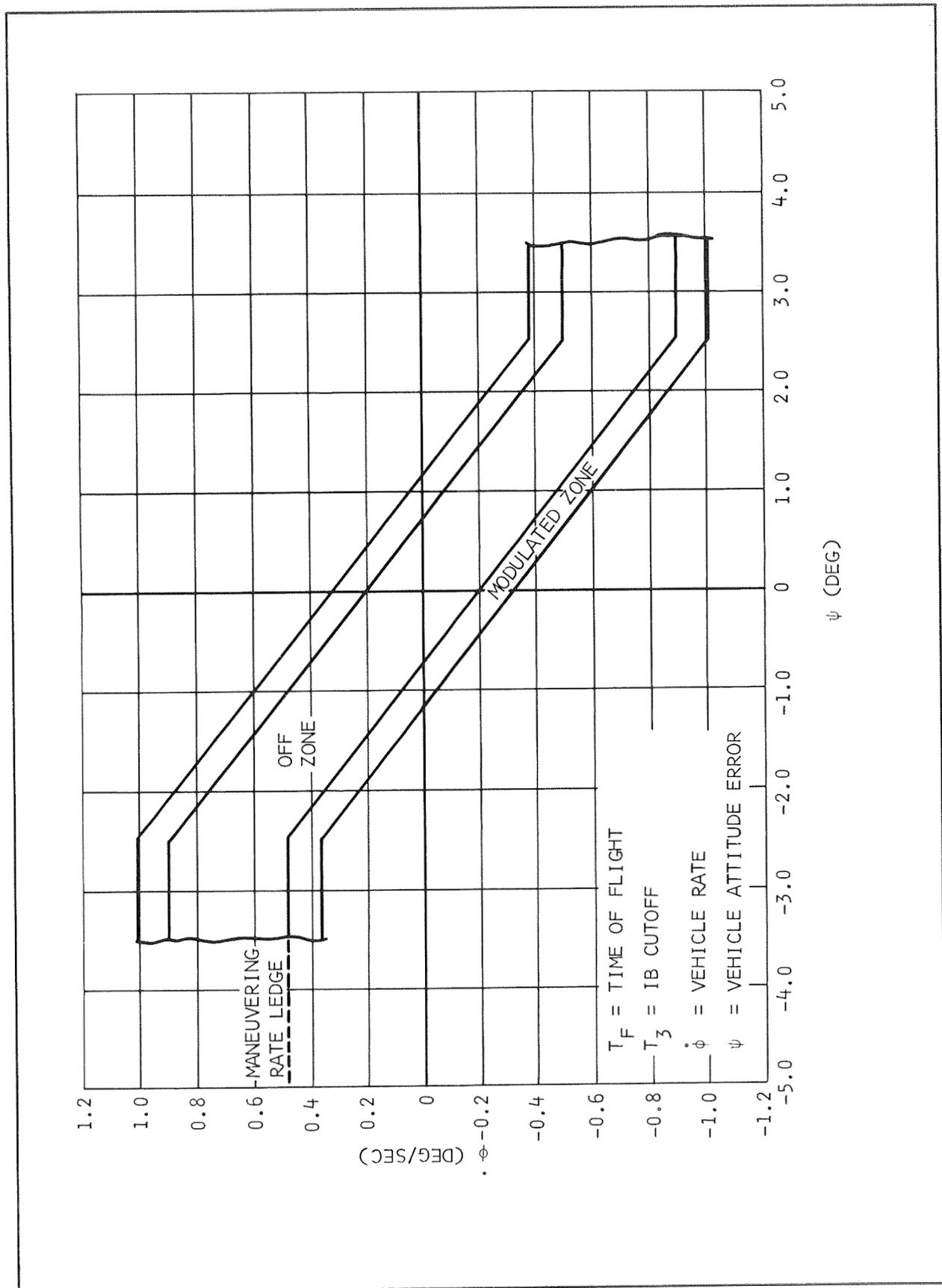


Figure AP 7-4. Auxiliary Attitude Control System Phase Plane - Roll ($T_F > T_3 + 1.0$)

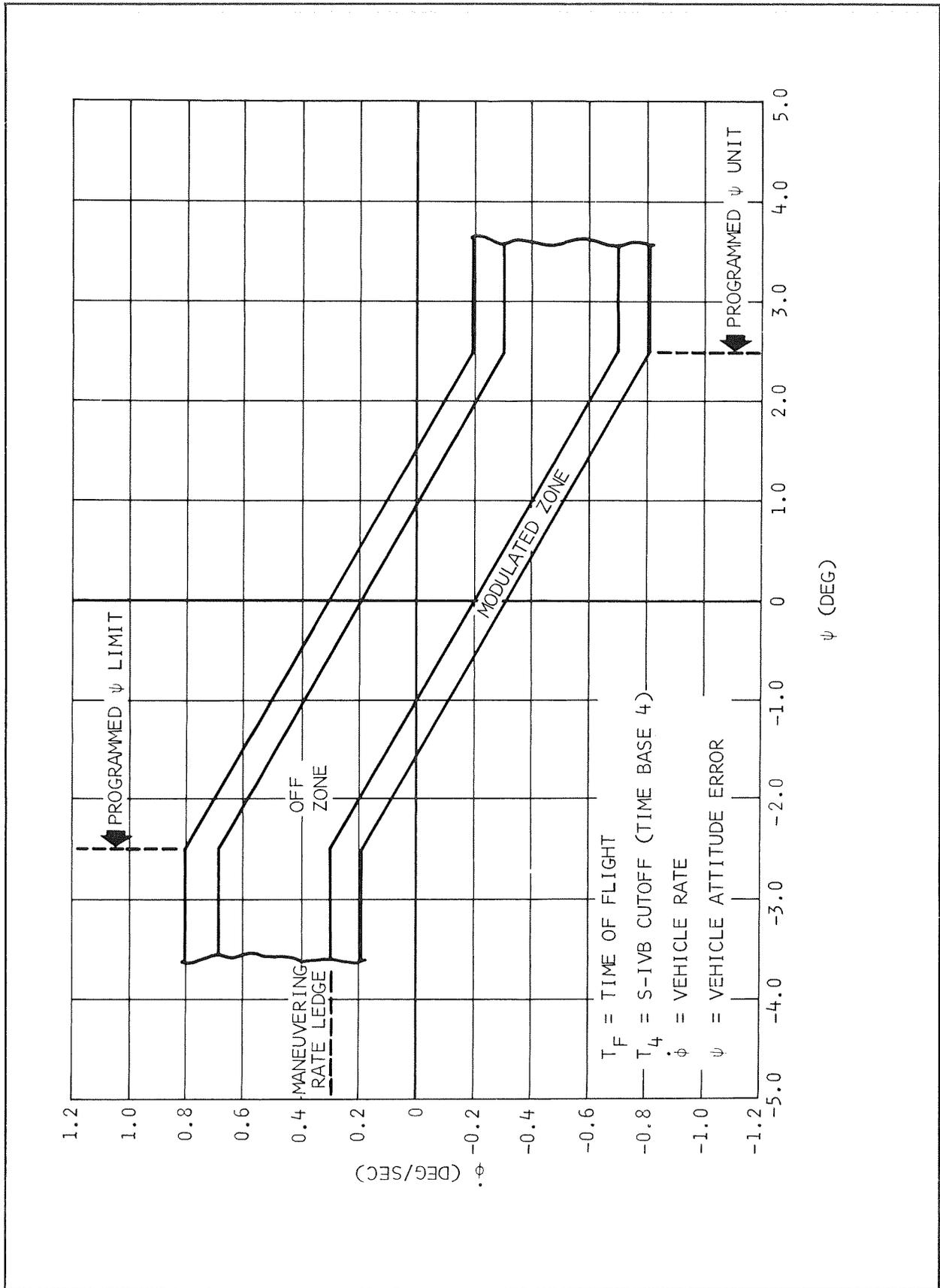


Figure AP 7-5. Auxiliary Attitude Control System Phase Plane - Pitch and Yaw ($T_F > T_4 + 5.0$)

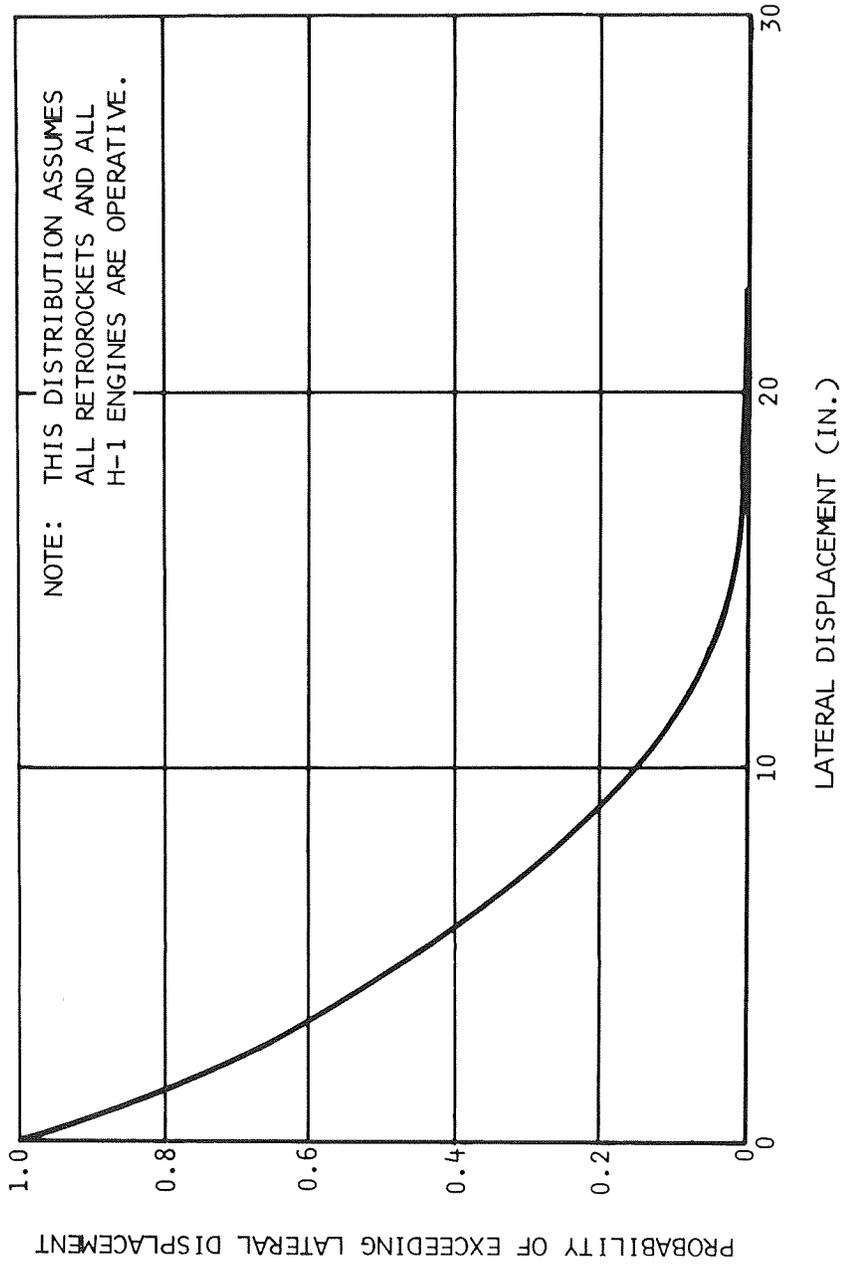


Figure AP 7-6. AS-206 S-IB/S-IVB Separation Probability of Lateral Displacement Exceeding a Specified Value

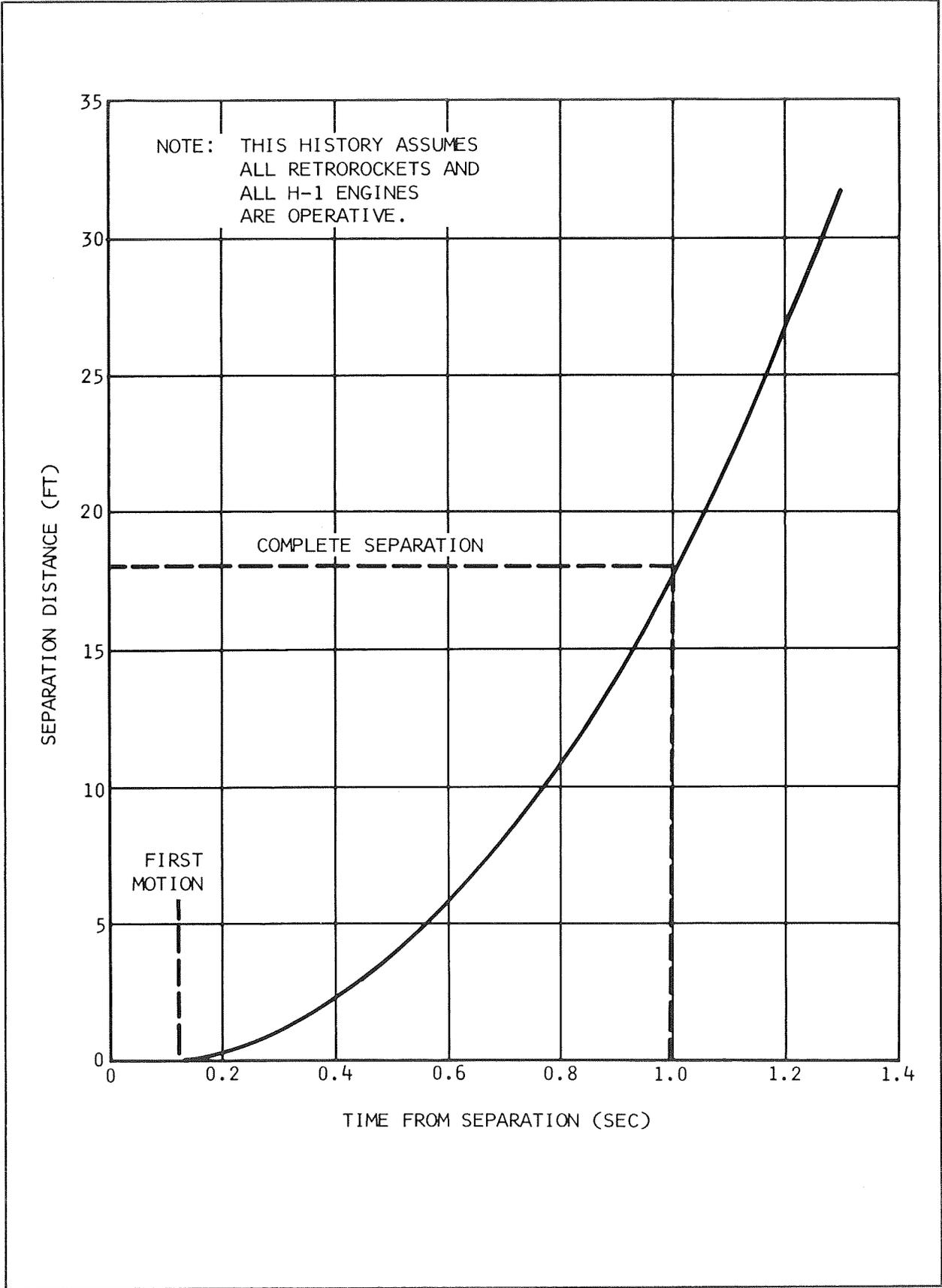


Figure AP 7-7. AS-206 S-IB/S-IVB Predicted Separation History

8. ADDITIONAL PREDICTED PERFORMANCE DATA

This appendix presents additional predicted performance data and design performance levels.

Figure AP 8-1 presents predicted S-IVB-206 hydraulic system operating levels, which are based upon acceptance firing data. Figures AP 8-2 and AP 8-3 show the forward and aft predicted battery load profiles based on the S-IVB-206 acceptance firing performance.

The data acquisition system performance levels include the following:

a. Radio Frequency

- (1) The signal strength of the RF link shall be greater than five microvolts at the receiver of one or more ground stations. The time shall be from acquisition at any station to loss of signal at that station.
- (2) The output of all RF assemblies shall be 15 watts minimum under all operative and environmental conditions.
- (3) The voltage standing wave ratio as computed from forward and reflected power shall not exceed 1.8:1.

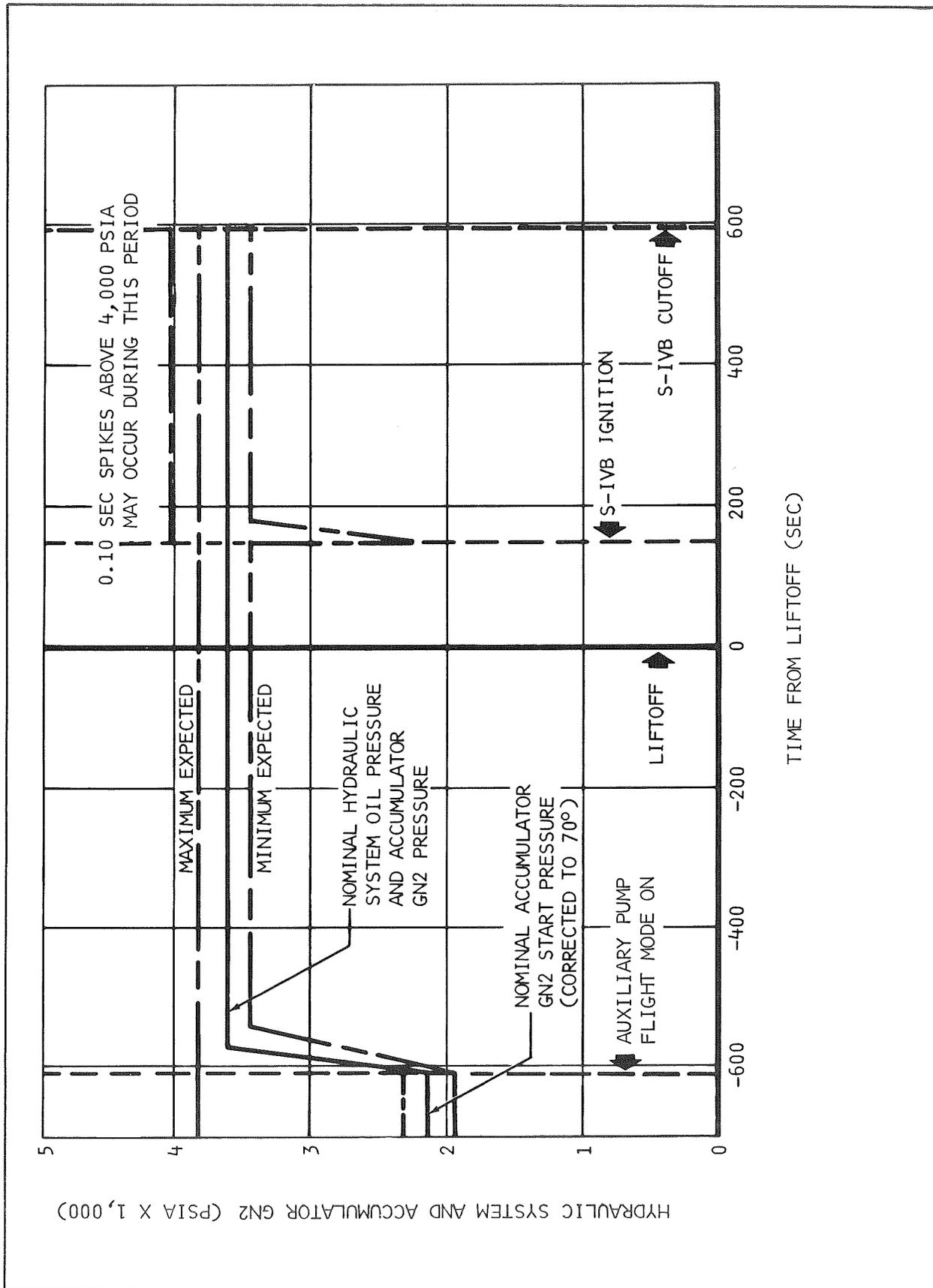


Figure AP 8-1. Predicted S-IVB-206 Hydraulic Operating Limits

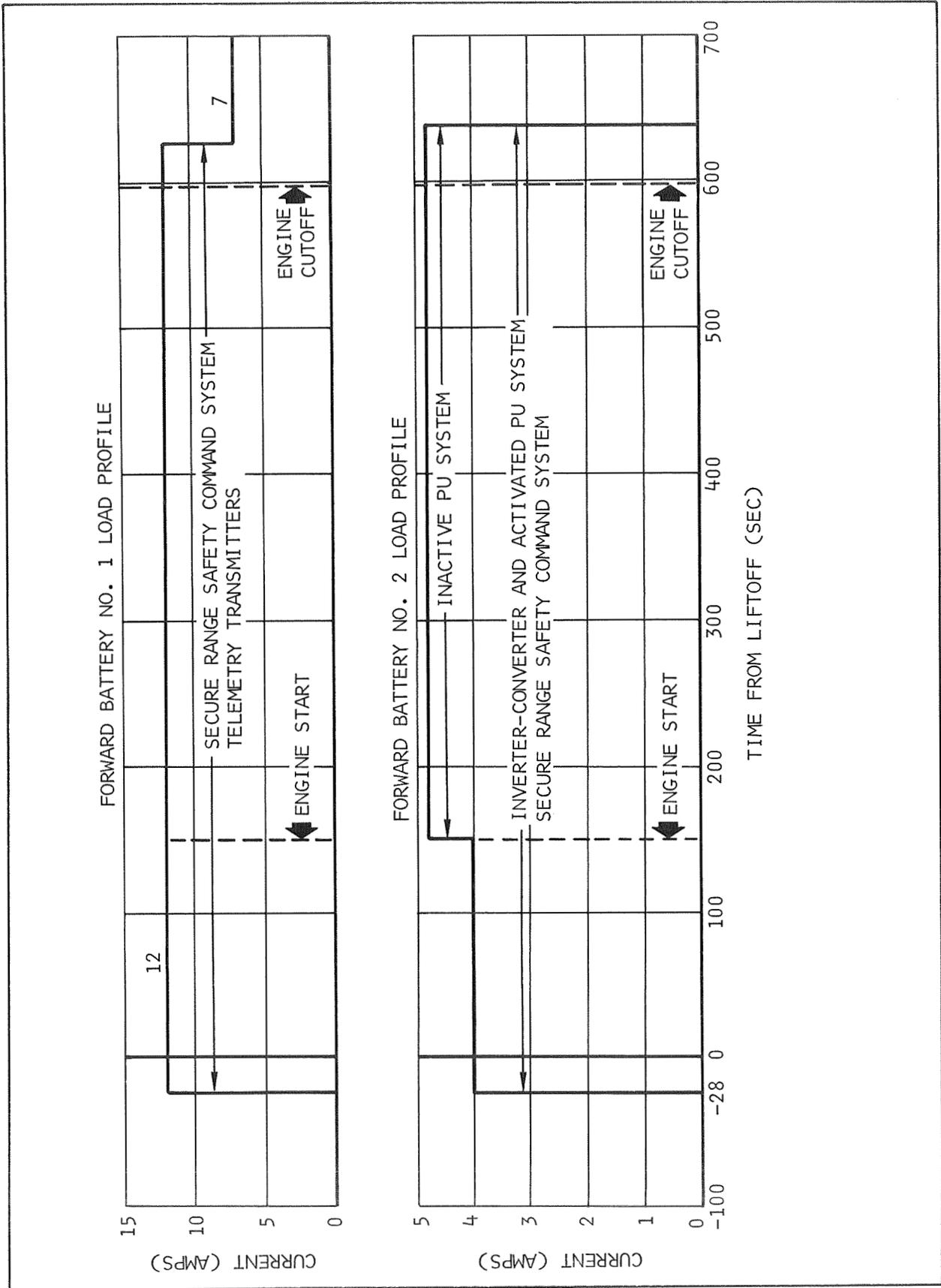


Figure AP 8-2. Predicted Load Profiles for Forward Batteries

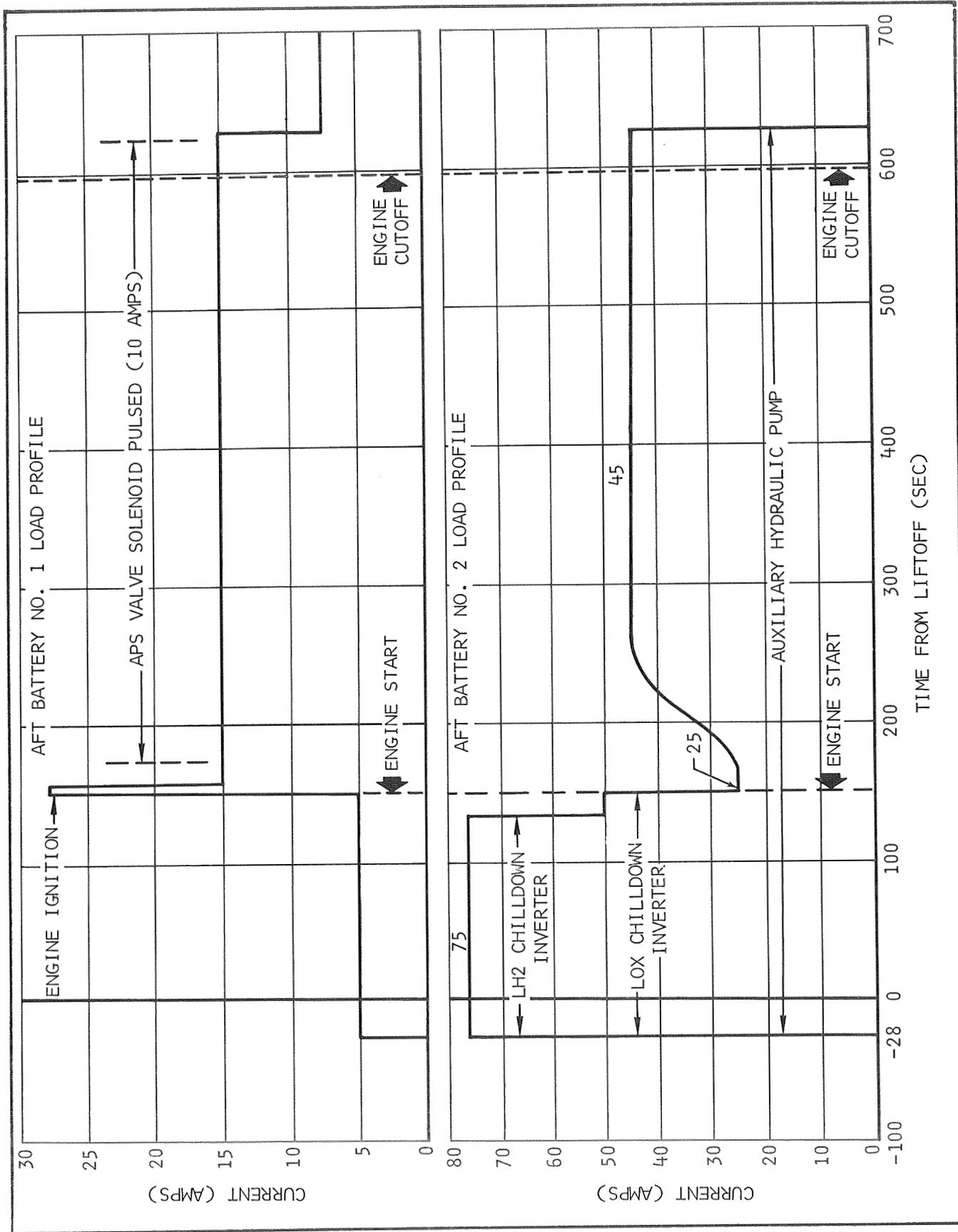


Figure AP 8-3. Predicted Load Profiles for Aft Batteries



9. RADIO FREQUENCY ALLOCATION

The following radio frequencies will be used for S-IVB-206 telemetry and range safety transmitters:

USAGE	FREQUENCY
PCM/FM	232.9 Mc
Secure Range Safety	450.0 Mc

10. GLOSSARY AND ABBREVIATIONS

This appendix (table AP 10-1) lists the commonly used S-IVB-206 stage flight test plan terms and abbreviations together with their definitions.

TABLE AP 10-1 (Sheet 1 of 12)
GLOSSARY AND ABBREVIATIONS

<u>Abbreviation</u>	<u>Term</u>	<u>Definition</u>
AA89	--	Designation of DAC propulsion system performance computer program
AA99	---	Designation of DAC meteorological system computer program
AACS	--	Auxiliary attitude control system
AB77	--	Designation of DAC S-IB trajectory simulation computer program
AB79	--	Designation of DAC Saturn S-IVB radar look angle computer program
ac	--	Alternating current
AC77	--	Designation of DAC S-IVB trajectory simulation computer program
--	Aerodynamically induced vibration	The oscillation of a mechanical system when set into motion by the turbulent boundary layer during flight. It is dependent on the shape and velocity of the body
amp	--	Ampere
APS	--	Auxiliary propulsion system
AS	--	Apollo Saturn
ASI	--	Augmented spark igniter
AST	--	All systems test
A_t	--	Throat area
aux	--	Auxiliary
--	Average mixture ratio	The time average of the propellant mixture ratio over 1-sec time intervals between 90 percent thrust buildup and Engine Cutoff Command
--	Average thrust or specific impulse	Determined between the time of 90 percent thrust and Engine Cutoff Command
A_w	--	Wind azimuth (deg)
A_{XM}	--	Axial acceleration (ft/sec ²)
BPC	--	Boost protective cover
Btu	--	British thermal unit
CDDT	--	Countdown demonstration test
CECO	--	S-IC stage Center Engine Cutoff Command

TABLE AP 10-1 (Sheet 2 of 12)
GLOSSARY AND ABBREVIATIONS

<u>ABBREVIATION</u>	<u>TERM</u>	<u>DEFINITION</u>
C_f	Collapse factor	A measure of the effectiveness of pressurization defined as: $C_f = \frac{M_{\text{actual}}}{M_{\text{theoretical}}}$, where M_{actual} is the mass necessary to pressurize the propellant tank (lbm) $M_{\text{theoretical}}$: is the mass necessary to pressurize the propellant tank if heat and mass transfer across the ullage boundaries are neglected (lbm)
CM	--	Command module
--	Composite data (acoustic and vibration)	The total energy of the oscillatory phenomenon, consisting of all frequencies and amplitudes sensed by the transducers, and represents the phenomenon at the point of measurement within the limitations of the data acquisition and reduction systems
cont	--	Control
CPIF	--	Cost plus incentive fee
cpm	--	Cycles per minute
cps	--	Cycles per second
CSM	--	Command Service Module
CVS	--	Continuous vent system
DAC	--	Douglas Aircraft Company, Inc.
DAC/FTC	--	Douglas Aircraft Company, Inc./ Florida Test Center
DAC/HB	--	Douglas Aircraft Company, Inc./ Huntington Beach
DAC/STC	--	Douglas Aircraft Company, Inc./ Sacramento Test Center
db	--	Decibel
dbm	--	10 log P (milliwatts) where p = power
dbw	--	10 log P (watts)
dc	--	Direct current
deg	--	Degree

TABLE AP 10-1 (Sheet 3 of 12)
GLOSSARY AND ABBREVIATIONS

<u>Abbreviation</u>	<u>Term</u>	<u>Definition</u>
--	Depletion Engine Cut-off Command	The time that engine cutoff was, or would be, initiated by the depletion level sensors
DDAS	--	Digital data acquisition system
DEE	--	Digital events evaluation
D/O	--	Dropout
DPS	--	Descent propulsion stage (part of lunar module)
DRSCR	--	Digital range safety command receiver
e	--	Eccentricity
EBW	--	Exploding bridgewire
ECA	--	Electrical control assembly
ECC	--	Engine Cutoff Command
ECF	--	End conditions of flight
ECP	--	Engineering change proposal
ECS	--	Environmental control system
EDS	--	Emergency detection system
--	Effective burntime	The engine burntime from 90 percent thrust buildup to Engine Cutoff Command
ELS	--	Earth landing system
EMC	--	Electromagnetic compatibility
EMI	--	Electromagnetic interference
EMR	Engine propellant mixture ratio	The ratio of engine LOX mass flowrate to LH2 mass flowrate. Includes gas generator operations
eng	--	Engine
--	Engine cutoff (applicable for original issue of flight test plans only)	The guidance cutoff time referred to in this issue of the test plan is intended to be a representative event time and should not be construed as the DAC predicted guidance cutoff time. The DAC predicted guidance cutoff time is undetermined at this date due to lack of trajectory information
--	Engine cutoff transient	Engine operation during the period from the Engine Cutoff Command until the end of thrust decay

TABLE AP 10-1 (Sheet 4 of 12)
GLOSSARY AND ABBREVIATIONS

<u>Abbreviation</u>	<u>Term</u>	<u>Definition</u>
EPS	--	Electrical power system
ESC	--	Engine Start Command
--	Engine start transient	Engine operation during the period from the Engine Start Command until the time of 90 percent thrust (approximately a 3-sec period)
--	Engine steady-state operation	Engine operation during the period from the time of 90 percent thrust until Engine Cutoff Command
ETD	--	End of thrust decay
env	--	Environmental
ETR	--	Eastern Test Range
°F	--	Degree fahrenheit
F	Stage longitudinal thrust	Thrust (lbf) developed by the J-2 engine. Ullage rocket thrust is not included
F823	--	Designation of DAC propulsion system performance computer program
F _a	--	Ullage rocket thrust (lbf)
--	Flow integral propellant mass history	That propellant mass history determined by combining independent engine analyses by a statistical method
FM	--	Frequency modulation
FPR	Flight performance reserve	Usable mass onboard at predicted guidance cutoff
fps	--	Feet per second
ft	--	Foot
FTC	--	Florida Test Center
g	Gravitational acceleration	The acceleration produced by the force of gravity, which varies with the altitude and elevation of the point of observation. The value 32.1739 ft/sec ² has been chosen as the standard by international agreement for sea level at 45° north latitude
G&N	--	Guidance and navigation

TABLE AP 10-1 (Sheet 5 of 12)
 GLOSSARY AND ABBREVIATIONS

<u>Abbreviation</u>	<u>Term</u>	<u>Definition</u>
GCC	--	Guidance Cutoff Command
GG	--	Gas generator
GH2	--	Gaseous hydrogen
GMT	--	Greenwich mean time
GN2	--	Gaseous nitrogen
GOX	--	Gaseous oxygen
gpm	--	Gallons per minute
GSE	--	Ground support equipment
GSFC	--	Goddard Space Flight Center, Greenbelt, Maryland
h	--	Altitude
h (AP)	--	Apogee altitude
HB	--	Huntington Beach, California
He	--	Helium
HF	--	High frequency
H-Q	--	Head vs discharge flowrate
hr	--	Hour
i	--	Inclination
IECO	--	S-IB stage Inboard Engine Cutoff Command
IGM	--	Iterative guidance mode
IMU	--	Inertial measurement unit
in./in.	--	Inches per inch (strain)
IPCL	--	Instrumentation Program and Components List
ips	--	Inches per second
I_{sp}	--	Specific impulse
I_t	--	Total impulse
IU	--	Instrument Unit
k	--	Insulation thermal conductivity
kc	--	Kilocycles
KSC	--	Kennedy Space Center

TABLE AP 10-1 (Sheet 6 of 12)
GLOSSARY AND ABBREVIATIONS

<u>ABBREVIATION</u>	<u>TERM</u>	<u>DEFINITION</u>
lbf	--	Pounds force
lbm	Pounds mass	1/32.1739 slug
LM	--	Lunar Module
LUT	--	Launcher umbilical tower
MDF	--	Mild detonating fuse
MHz	--	Millihertz
Mod	--	Module
MOV	--	Main oxidizer valve
ms	Millisecond	Thousandth of a sec
MSC	--	Manned Spacecraft Center, Houston, Texas
MSFC	--	Marshall Space Flight Center
MSFN	--	Manned Space Flight Network
mvdc	--	Millivolt - direct current
mxr	--	Multiplexer
N/A	--	Not applicable
NASA	--	National Aeronautics and Space Administration
NC	--	Normally closed
--	Ninety percent thrust buildup	Time from Engine Start Command until the last engine chamber pressure (injector end) reaches 618 psia
nmi	--	Nautical mile
NO	--	Normally open
No.	--	Number
N ₂ O ₄	NTO	Nitrogen Tetroxide
NPSH	--	Net positive suction head
NPV	--	Nonpropulsive vent
OAT	--	Overall test
OECO	--	S-IB or S-IC stage Outboard Engine Cutoff Command
O-P	--	Zero to peak
oxid	--	Oxidizer

TABLE AP 10-1 (Sheet 7 of 12)
GLOSSARY AND ABBREVIATIONS

<u>Abbreviation</u>	<u>Term</u>	<u>Definition</u>
P	--	Pitch
P _a	--	Ambient pressure
P _c	--	Combustion chamber pressure measured at the injector
PA	--	Pressure actuated
PA49	--	Designation of DAC propulsion system performance computer program
PAM	--	Pulse amplitude modulation
--	Payload	All portions of the vehicle above the S-IVB/IU
PCF	--	Preconditions of flight
PCM	--	Pulse code modulation
PD	--	Propellant dispersion
PMR	Programmed mixture ratio	A method of controlling the PU valve mixture ratio to obtain maximum efficiency of the stage. The propellant loading is provided to cause the PU system to command the PU valve against the LOX rich stop for the initial portion of flight and then decrease to a lower mixture ratio during the final portion of flight
P/N	--	Part number
ppm	--	Parts per million
--	Propellant residuals	The sum of LOX and LH2 remaining on-board at Engine Cutoff Command. The residuals include both usable and trapped propellants
PS	--	Pressurization system
P/S	--	Pulse sensor
PSD	--	Power spectral density
psia	--	Pounds per square inch absolute
psid	--	Pounds per square inch differential
psig	--	Pounds per square inch gauge
PTCS	--	Propellant tanking computer system
P/U	--	Pickup
PU	--	Propellant utilization

TABLE AP 10-1 (Sheet 8 of 12)
GLOSSARY AND ABBREVIATIONS

<u>Abbreviation</u>	<u>Term</u>	<u>Definition</u>
--	PU system propellant mass history	That propellant mass history determined for flight by the PU system
--	PU system residuals	Those propellant residuals above the main propellant valves determined by the PU system
q	--	Dynamic pressure
qty	--	Quantity
°R	--	Degree rankine
RACS	--	Remote analog calibration system
RCS	--	Reaction control system
reg	--	Regulator
RF	--	Radio frequency
RFI	--	Radio frequency interference
rms	--	Root mean square
RO	--	An event time used as reference for S-IVB stage flight evaluation sequence of events. Defined as the first Greenwich mean time second prior to vehicle liftoff
RP	--	Reference plane
rpm	--	Revolutions per minute
R/S	--	Range safety
RSCR	--	Range safety command receiver
rss	--	Root sum square
S	--	Surface range (ft)
S&A	--	Safe and Arm device
scfm	--	Standard cubic ft/min
scim	--	Standard cubic in./min
sco	--	Subcarrier oscillator
SCS	--	Stabilization and control system
sec	--	second
S-II	--	Second stage of the Saturn V (500) series of vehicles
S-IB	--	First stage of the Saturn IB (200) series of vehicles

TABLE AP 10-1 (Sheet 9 of 12)
GLOSSARY AND ABBREVIATIONS

<u>Abbreviation</u>	<u>Term</u>	<u>Definition</u>
S-IC	--	First stage of the Saturn V (500) series of vehicles
S-IVB	--	Second stage of the Saturn IB (200) series of vehicles and third stage of the Saturn V (500) series of vehicles
SLA	--	Spacecraft LM adapter
SLO	--	Simulated liftoff
--	Slug	English system unit of mass
SM	--	Santa Monica
SM	--	Service module
SPS	--	Service propulsion system
SOV	--	Shutoff valve
SS	--	Single sideband modulation
SSB	--	Single sideband
SSS	--	Stage switch selector
sta	--	Station
--	Statistical weighted average loaded propellants	The most accurate determination of actual propellant load at liftoff as derived from the statistically weighted average mass
--	Statistical weighted average mass determination	A statistical combination of the PU system, engine system, flight simulation, and propellant level sensors at Engine Start Command and Engine Cutoff Command
--	Statistical weighted average residual propellants	The most accurate determination of actual propellant residuals at Engine Cutoff Command as derived from the statistically weighted average mass determination method
STC	--	Sacramento Test Center
S/V	--	Space vehicle
Sw sel	--	Switch selector
T	--	Countdown time from prospective liftoff or as specifically defined in the text
TBD	--	To be determined
Tel 2	--	Telemetry station at KSC
tk	--	Tank
T/M	--	Telemetry

TABLE AP 10-1 (Sheet 10 of 12)
GLOSSARY AND ABBREVIATIONS

<u>Abbreviation</u>	<u>Term</u>	<u>Definition</u>
TPEP	--	Telemetry performance evaluation period
TWX	--	Teletype
--	Total depletion burn-time	The engine burntime from Engine Start Command to the time that the Depletion Engine Cutoff Command would have been initiated
--	Total propellants consumed	That amount of liquid propellants consumed from Engine Start Command to Engine Cutoff Command. Includes engine consumption, boiloff, and LH2 tank pressurant
--	Total stage burntime	The engine burntime from Engine Start Command to Engine Cutoff Command
--	Total stage mass history	A compilation of all final hardware, propellant, and gas masses. The measured and computed mass of each constituent is adjusted within its accuracy band so that the total stage mass at Engine Start Command and Engine Cutoff Command agrees with the total stage mass as determined by the Statistical Weighted Average mass determination method
TP&E	--	Test Planning and Evaluation
--	Unusable propellants	Those propellants remaining after a propellant depletion cutoff. This includes the propellants in the tank below the depletion sensor, propellants in the feed duct, and trapped propellants. It does not include sensor lag time or the propellant consumed during engine cutoff but does include sensor time delay
U/R	--	Ullage rocket
--	Usable residuals	Propellants in excess of trapped propellants left onboard a stage after powered flight has been terminated by some specified cutoff criteria
v	--	Volt
V_E	--	Relative velocity

TABLE AP 10-1 (Sheet 11 of 12)
GLOSSARY AND ABBREVIATIONS

<u>Abbreviation</u>	<u>Term</u>	<u>Definition</u>
V_I	--	Inertial velocity
V_{RM}	--	Freestream velocity
V_W	--	Wind speed
VAB	--	Vehicle Assembly Building, KSC, Florida
vac	--	Voltage, alternating current
vdc	--	Voltage, direct current
VCO	--	Voltage controlled oscillator
VHF	--	Very high frequency
VSE	--	Vehicle support equipment
VSWR	--	Voltage standing wave ratio
w	--	Watt
WRO	--	DAC work release order
WS11	--	Designation of DAC mass characteristics computer program
wt	--	Weight
\dot{W}_T	--	Time rate of change of total vehicle weight
X_E	--	Downrange distance
\dot{X}_E	--	Downrange velocity
Y	--	Yaw
Y_E	--	Vertical distance
\dot{Y}_E	--	Vertical velocity
Z_E	--	Crossrange distance
\dot{Z}_E	--	Crossrange velocity
α_p	--	Pitch angle of attack
α_q	--	Product of angle of attack and dynamic pressure
α_Y	--	Yaw angle of attack

TABLE AP 10-1 (Sheet 12 of 12)
 GLOSSARY AND ABBREVIATIONS

<u>Abbreviation</u>	<u>Term</u>	<u>Definition</u>
γ_1	--	Earth fixed flight path elevation angle
γ_{1I}	--	Inertial flight path elevation angle
γ_{2I}	--	Inertial flight path azimuth angle
μ	--	Longitude
μ in./in.	micro inch per inch	Millionth of an inch
μv	--	Microvolt
ρ	--	Geodetic latitude

11. REFERENCES

The following is a complete list of the references as used in this test plan. The documents are listed in the same order as mentioned in the text of the report and in the appendices.

- (1) Apollo Flight Mission Assignments (U), (prepared by Office of Manned Space Flight), M-D MA 500-11 SE010-000-1, National Aeronautics and Space Administration, Washington, D.C., 10 September 1965.
- (2) Apollo-Saturn IB Program Support Requirements, (prepared by Office of Manned Space Flight), No. 4200, Part I, National Aeronautics and Space Administration, Washington, D.C., 3 January 1966 (revised page 120.20, dated 1 March 1966).
- (3) MSFC Flight Mission Directive Apollo-Saturn 206 Mission, (prepared by Saturn I/IB Program Office), Marshall Space Flight Center, Huntsville, Alabama. The document is to be published in the future.
- (4) S-IVB-206 Stage End Item Test Plan, (prepared by Douglas Aircraft Company, Inc., Huntington Beach, California), 1B63904, 21 January 1966.
- (5) Instrumentation Program and Components List Saturn S-IVB-206, (prepared by Douglas Aircraft Company, Inc., Huntington Beach, California), 1B43559, Change F, 1 August 1966.
- (6) Apollo/Saturn IB Launch Mission Rules, AS-206, (prepared by Kennedy Space Center). The document is to be published in the future.
- (7) Terminal Count Observer Redline Values, AS-206, (prepared by Kennedy Space Center). The document is to be published in the future.
- (8) Test Specification and Criteria, KSC Prelaunch Checkout and Launch Operations, S-IVB-IB, (prepared by Douglas Aircraft Company, Inc., Huntington Beach, California), 1B66261, 3 August 1966.

- (9) Facility and Environmental Measurements Program, (to be prepared by Kennedy Space Center a few weeks prior to the AS-206 launch).
- (10) Contract End Item Detail Specification (Prime Equipment) Performance Design Requirements, CEI No. 208006A, S-IVB Stage for Use With the Saturn Vehicle SA-206, (published by Douglas Aircraft Company, Inc., Huntington Beach, California), 1 December 1965.
- (11) Specification for the Calculation of Payload Capability Under the CPIF Exhibit to NAS7-101, (prepared by Douglas Aircraft Company, Inc., Huntington Beach, California), SM-47263, 12 January 1966.
- (12) Interface Control Document, Definition of Saturn SA-206 Flight Sequence Program, (prepared by Airborne Electrical Systems Branch Astrionics Laboratory), 40M33606, National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Huntsville, Alabama, May 31, 1966.
- (13) Saturn IB, AS-206 Mass Characteristics, (published by George C. Marshall Space Flight Center), memorandum R-P&VE-VAW-66-62, July 13, 1966.
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